Tappi

PUBLISHED BY THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY

JUNE 1951

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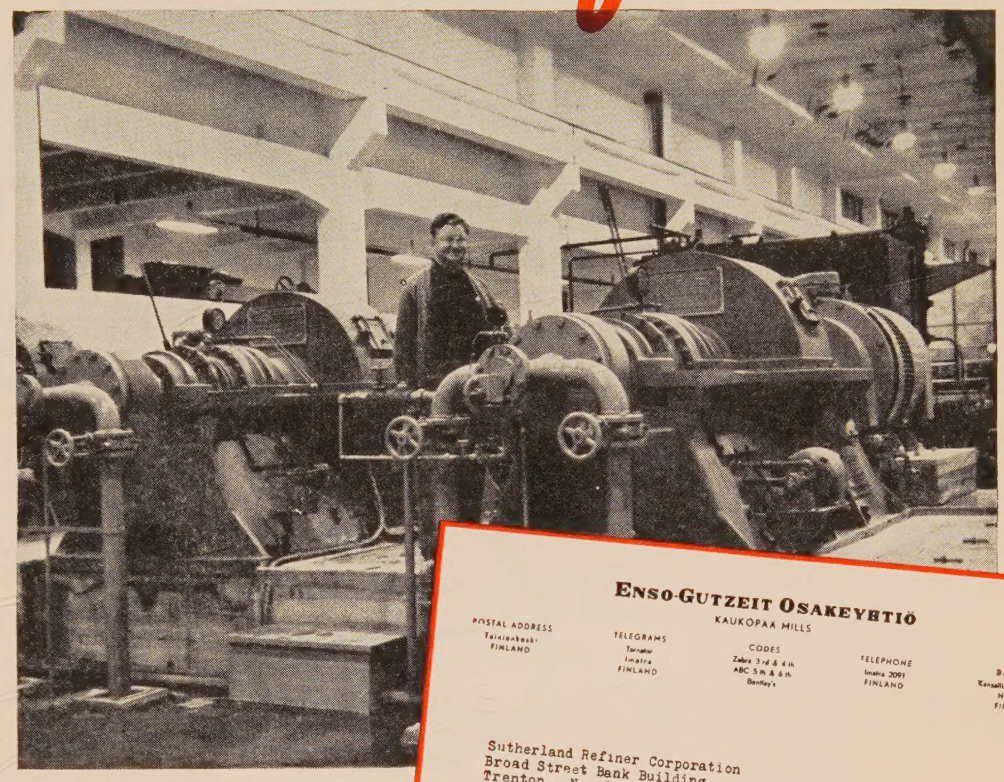

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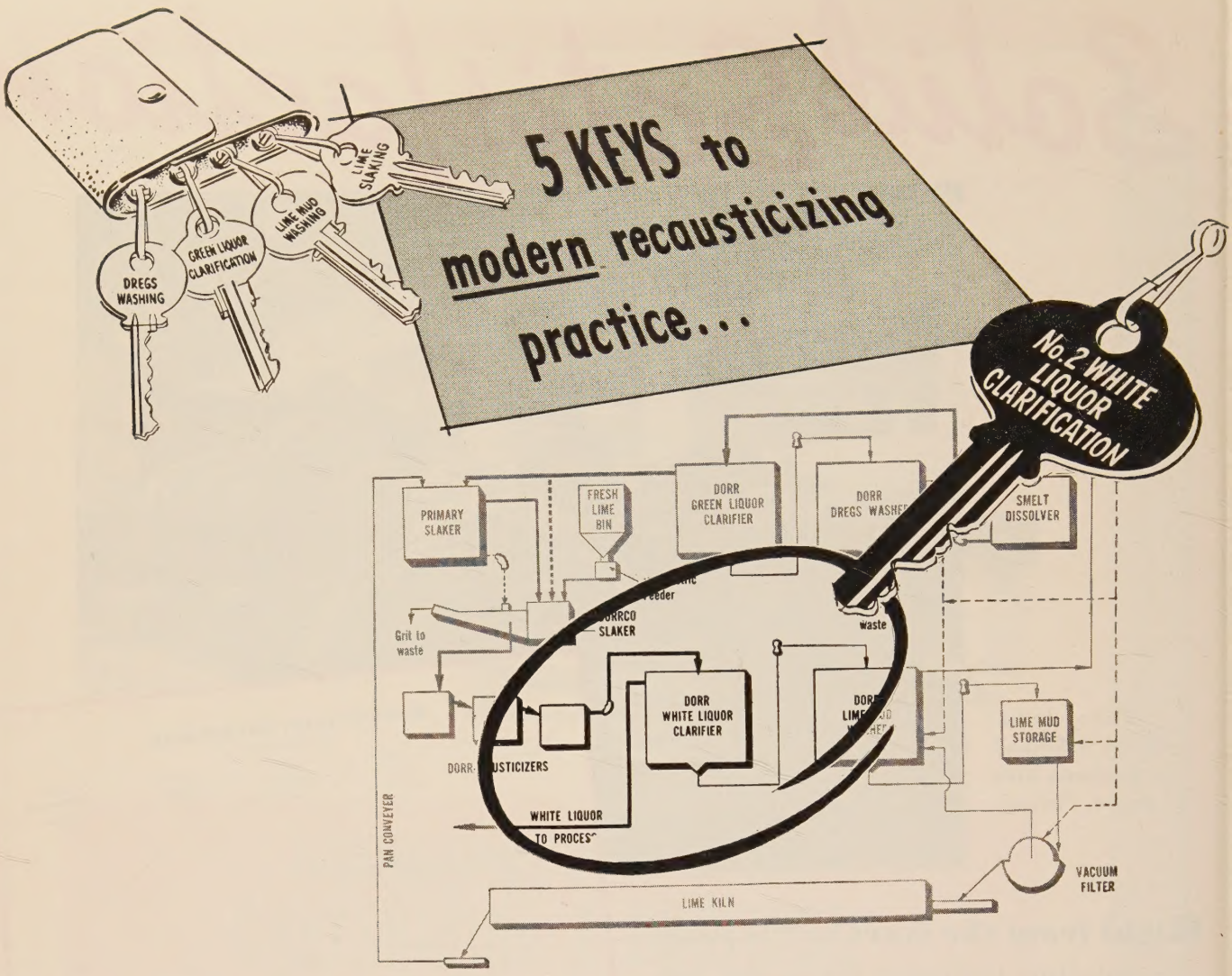

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According to tradition, these keen blades were laboriously hammered at the forge until they resembled the "color of the moon" when quenched. To test the cutting edge, the blade was placed in a slow stream —cutting edge upstream. A piece of silk was floated downstream; if it was severed on contact, the blade was acceptable!

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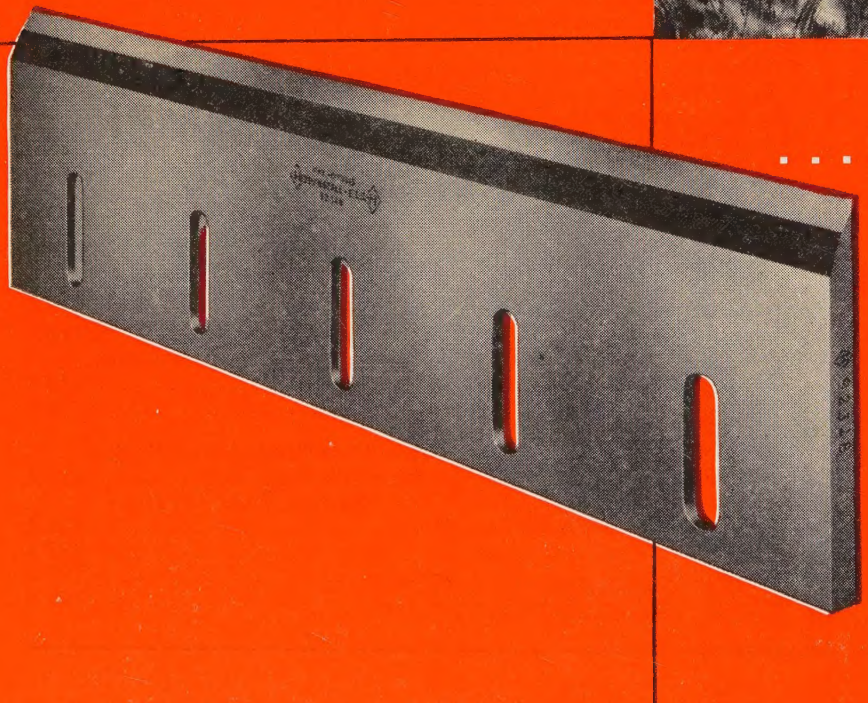

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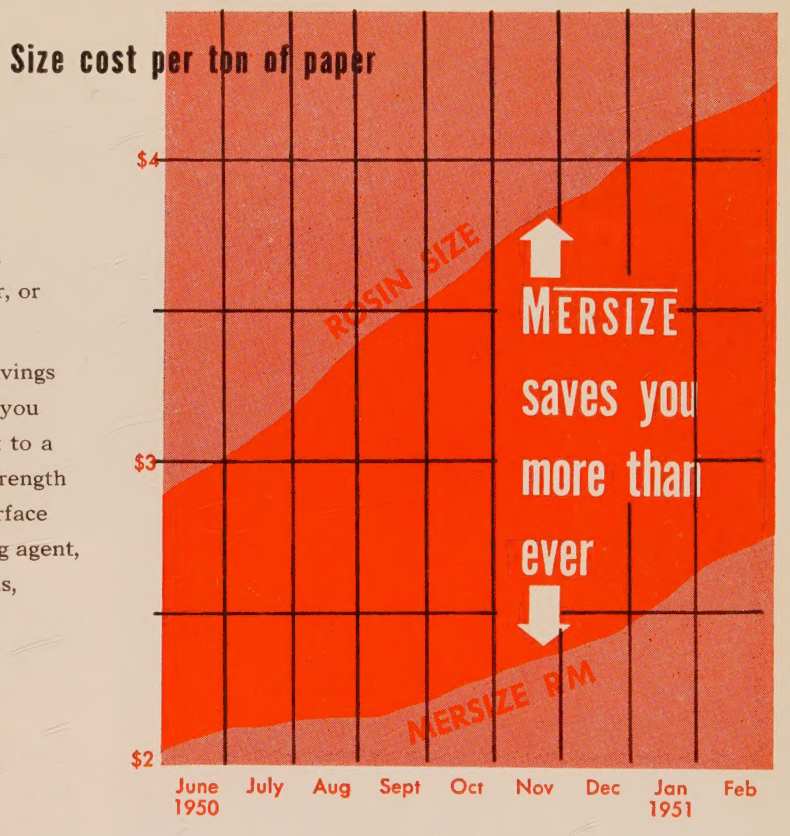

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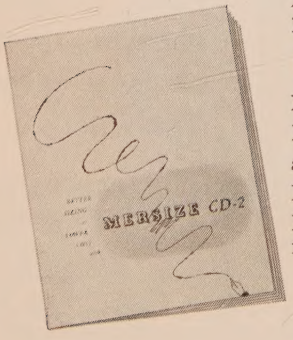

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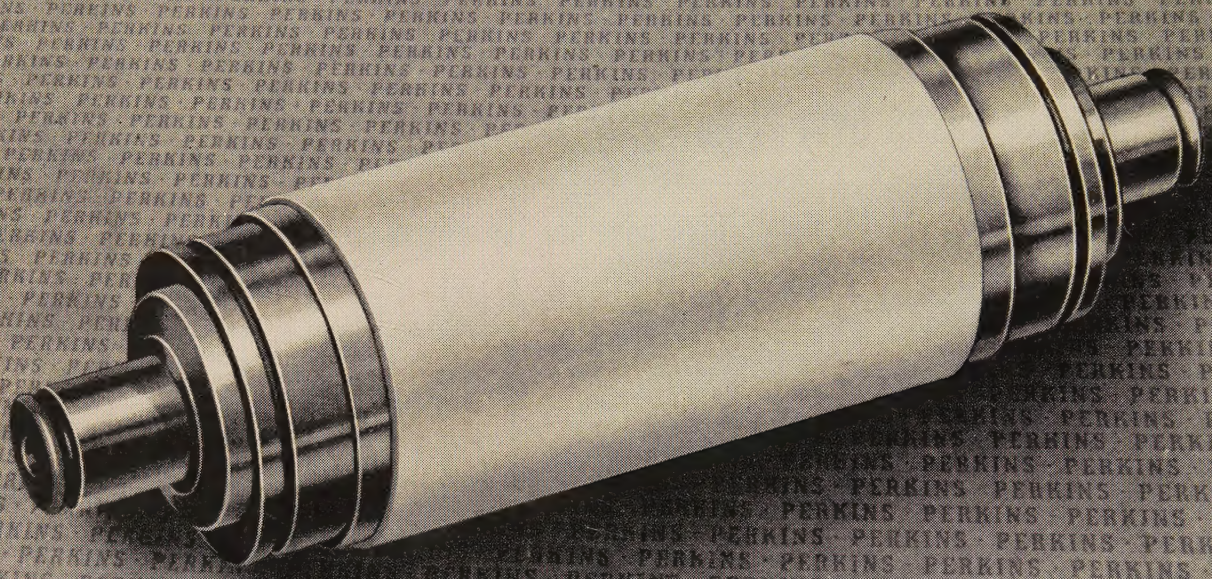

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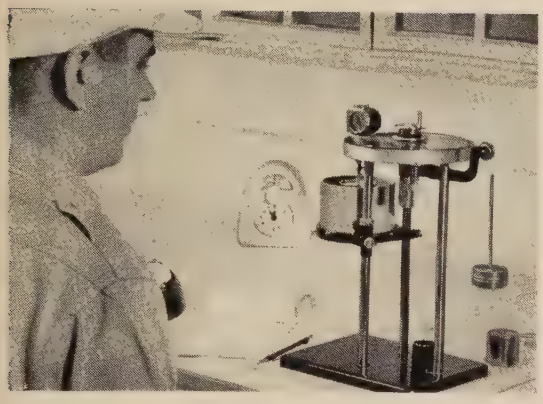

Determining viscosity of clay suspensions with the Stormer Viscometer at the Huber Clay Laboratories.

EVALUATING MINING CORE SAMPLES The evaluation of mining core samples is an important step in assuring uniform clays. The complete Huber cycle of laboratory tests consists of 12 separate steps; some of the more important are listed below:

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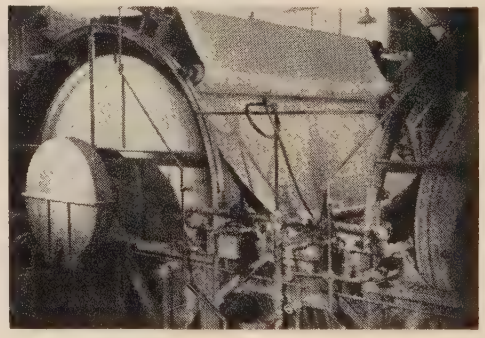
2. Grit determination for each composite on 200 and 325 mesh screens.
3. Blunging and fractionating each composite so that the recovered fraction is composed of particles 75–80% by weight, finer than two microns.
4. Determining brightness of the purified and bleached composites.
5. Determining flow properties of the purified and bleached composites in a 70% clay-water system and in standard casein and starch colors. The ease of disintegration or "make down" is also observed.
6. Comparing composites against standards established for the paper and other industries.

PROCESSING KAOLIN CLAYS BY THE WET METHOD The wet process deals with clay particles suspended in water. This process is very complex, involving the separation of water-suspended clay fractions with controlled particle size ranges, the bleaching or whitening of the clay by chemical means, filtration and drying.

Modern production of water washed clays is accomplished in several stages: blunging—the initial disintegration of the crude clay lumps in water; fractionation—the separation of fractions with definite particle size ranges; bleaching—removal of the discoloration caused by iron compounds; filtration and drying of the filter cake.



Continuous drum type filter for water washed clay.

Have you received your copy of "Kaolin Clays and their Industrial Uses"—new Huber 144-page technical reference book? Write on your company letterhead.

EFFECT OF PARTICLE SHAPE ON FLOW CHARACTERISTICS

The shape of the clay particle is of major importance in controlling the flow of highly concentrated mixtures. During the flow of such mixtures, the solid particles are continually being rotated. Unless a volume of liquid having a diameter equal to the greatest length of the solid particles is available, the particles are apt to interfere with one another during rotation and produce resistance to flow. This phenomenon occurs freely in such threadlike molecules as rubber which produce high viscosities in very dilute concentrations. It follows, then, that solids composed of needles of thin plates should develop excessive viscosities when the systems become too crowded for free rotation. On the other hand, much larger quantities of cubical or spherical particles would produce freer suspensions. A recently published paper (*Paper Trade Journal*, February 16, 1951) from Huber laboratories discusses methods for controlling the viscosity of concentrated clay suspensions.

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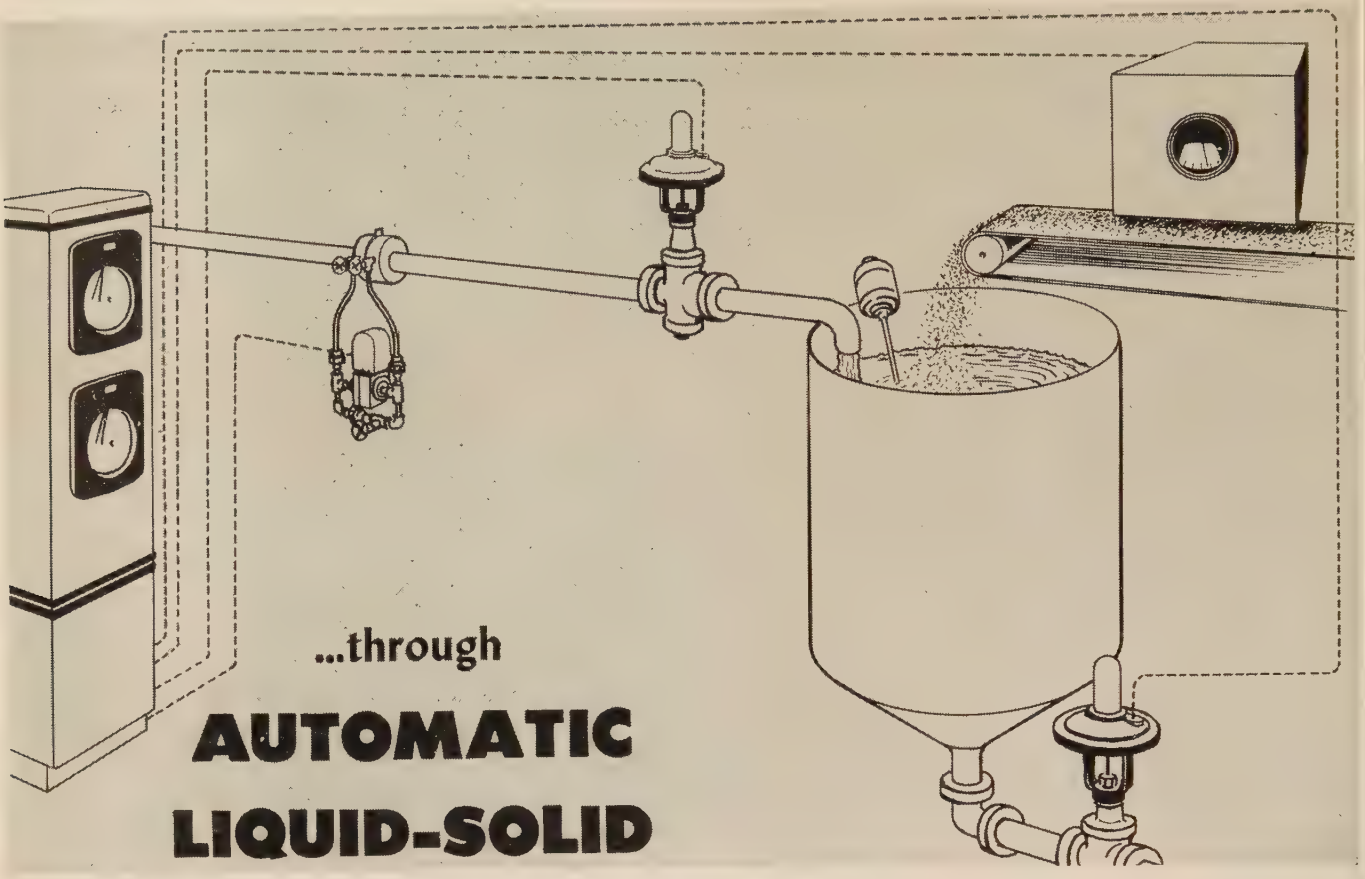

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This illustration shows Foxboro Ratio Control installed in a large modern mill. A Merrick Weightometer equipped with a Foxboro Pneumatic Motion Transmitter appears in the foreground.

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The Chemical Engineer, His Function in Industry

W. L. BADGER

I PREFER rather to speak about the role of the chemical engineer, and to let the application of his work to the paper industry rest in the hands of those who know more about pulp and paper manufacture than I do. If I were to attempt a basic definition of the work of a chemical engineer, I would say it is the application of our knowledge of the unit operations to the chemical and process industries. This, like most definitions, involves a term that must be still further expanded and explained; that is, what do we mean by the unit operations?

DEVELOPMENT OF THE CHEMICAL AND PROCESS INDUSTRIES

The chemical and process industries went through their most important processes of development in Germany during the last century and up to the outbreak of the World War in 1914. In many parts of the world such process industries as were established followed closely after the German pattern. The teaching of German schools, German methods of thinking, German methods of working, and the information in German textbooks were widely adopted in all those countries where chemical and process industries developed. It was a characteristic of this period that each industry was thought of as in a watertight compartment by itself. The development of a knowledge of processes and equipment was carried out industrywise without any real understanding of the fact that many processes are basic to almost all industries. The result is that one found a very high development of the technology of the alkali industry, the acid industry, the soap industry, the paper industry, the leather industry, etc., but no particular interchange of ideas between the different industries. So, for instance, the multiple effect evaporator was first built in 1843 in the sugar industry. This idea received considerable attention and rose to a rather high degree of development in Germany from 1850 on. As an illustration of how completely different industries were separated, it should be noted that the first multiple effect evaporator was used in the salt industry in the United States in 1888, and it was really not until after 1910 that multiple effect evaporators were generally adopted in other industries. Today a very large amount of the salt made in Germany is still made in the old direct-fired flat pans. Much salt produced in England is still so made.

In contrast with the above, consider the case of filtration. The Germans developed the filter press, and the filter press is a perfectly satisfactory method of filtration provided labor is cheap enough. Everywhere that filtration was carried out, it was always done with filter presses, and that is one case in which a method of filtration was common to many industries. However, with the rise of the cyanide process for the extraction of gold, and the necessity for filtering very large volumes of solids at a very low unit cost per ton of solids, it soon became obvious that the filter press could not be successful. The first filter that was developed in this country was the Moore filter in which filter leaves were hung in a tank where filtration was carried out, then they were hung in a tank where cake was washed, then in another tank where the cake was blown off. Very quickly thereafter the Butters filter was developed in which the filter basket was stationary in one tank and different liquids were supplied. But both of these methods, so greatly superior to the filter press, were practically unknown outside the metallurgy of gold. Then Kelly got the idea of putting the filter basket, the bundle of filter leaves, inside a cylindrical container and pumping the liquids through by pressure. It happened that Kelly was working in Salt Lake City and was familiar with the beet sugar industry. After the Kelly press was quite successful in the cyanide industry, he tried it in the beet sugar industry, and within the next ten years the Kelly press went completely around the world in both beet and cane factories. Sweetland modified this by hanging the filter leaves at right angles to the cylinder instead of longwise, and then Oliver got the idea of wrapping the filter leaf around the cylinder, making the process continuous. Here again this filter was widely known and widely used for years in the recovery of gold by the cyanide process before anybody ever thought of adapting it to the other chemical industries. But all of these filters, once adapted to other processes than the cyanide process for gold, proved their adaptability. Such a thing could hardly have happened under the old German idea of keeping each industry in a watertight compartment.

UNIT OPERATIONS

The greatest advance along this line took place when Arthur D. Little evolved the idea of unit operations. His thought was that such operations as the flow of heat, the flow of fluids, evaporation, filtration, distillation, crystallization, and so on through a long list, were operations that could be studied as *operations*, independent of the industry in which they were used, and the results could be applied to any industry in which these operations were used. This conception probably had more to do with the development of chemical engineering as we know it today than any other one idea.

Little may have thought that he was developing a new conception, but actually it had been thought of long before, but quite completely forgotten. I am reading from a little book written by Paracelsus, the great alchemist, in 1571.

"Book VII. Regarding Transmutations.

"To write of the transmutation of all natural things, it is first desirable and necessary to point out what transmutation may be.

W. L. BADGER, Consulting Engineer, Ann Arbor, Mich.

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"Second, the degrees and steps of the same.

"Third, by what means and in what way the same occur.

"Now, transmutation is that a thing shall lose its form and appearance and become completely changed. It does not show, therefore, its first substance and form any more, but takes upon itself another form, another substance, another being, another color, another virtue, another nature or property. As, for instance, when a metal becomes glass or stone,[1] wood becomes stone,[2] stone becomes coal,[3] clay becomes stone and bricks, leather becomes glue, cloth becomes paper, and many others of the same sort.[4] These all are transmutations of natural things.

"After this it is also highly necessary to know the degrees and steps of transmutations and how many these may be. Such degrees are not more than seven. Although some people count more, this is not so, and the most important steps are seven. The others, however, which might be counted as steps are included in the above, and these steps are as follows: calcination, sublimation, solution, putrefaction,[5] distillation, coagulation,[6] and coloration.

"Whoever ascends these seven steps shall come to such a wonderful place that he shall see and experience many secret things in the transmutation of all natural substances."

Paracelsus, of course, had no influence in this respect, but Little's concept of the unit operations proved to be an extremely valuable tool and marked the beginning of the rapid development of chemical engineering that has been seen in the last 25 years. It is interesting to note the results of this understanding of the unit operations. In those unit operations where the theory is pretty well understood and equipment can be designed from the basis of well-understood principles, the great multiplicity of designs seems to have disappeared. In those unit operations where the theory is little understood, the multiplication of designs is quite noticeable. So, for instance, distillation has had a very exhaustive study in recent years, and the result is that a distillation column is simply a distillation column. There are no longer designs on the market known as A's method of distilling and B's method of

[1] Slag or oxide.
[2] Charcoal.
[3] ?
[4] A pretty fair definition of the process industries
[5] Oxidation.
[6] Precipitation.

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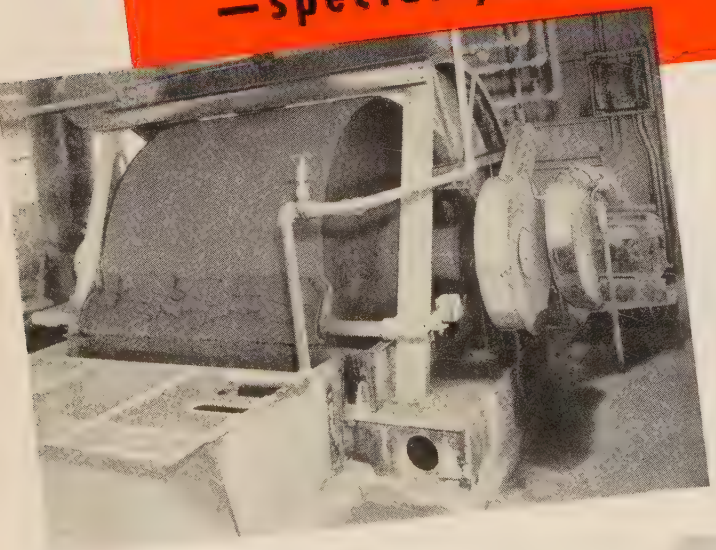

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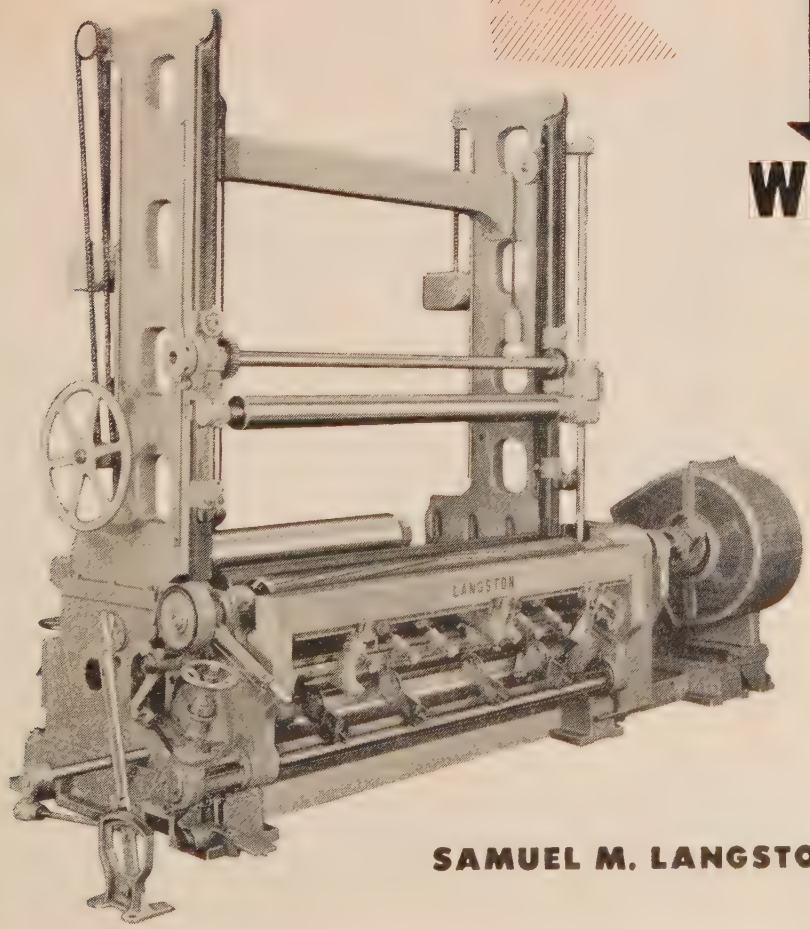

SAMUEL M. LANGSTON COMPANY, CAMDEN, N.J.

distilling and C's method of distilling, but simply a distillation column. Much the same has occurred with evaporators. On the other hand, if one looks at the unit operation of crushing and grinding, he finds a wide variety of designs; and for many jobs, if a dozen firms are asked to bid on a crushing job, one will find a dozen radically different designs of crushers submitted. This differentiation has gone so far that it is practically the hallmark of the degree to which the operation is understood. The better the operation is understood, the simpler and more uniform is the equipment, and the differences in designs become, then, merely such minor differences as are necessary properly to adapt the equipment to the particular materials or the particular industry in which it is used.

ACTIVITIES OF CHEMICAL ENGINEERS

If, then, the principal field of the chemical engineer is in understanding the design and operation of the equipment of the unit operations, why, you may ask, does he appear in the paper industry, and why isn't he simply employed by the manufacturers of equipment? You may think that if you want a still or an evaporator or a drier or any other piece of equipment that falls under the classification of unit operations, you go to the equipment manufacturers and they design the apparatus to fit your process. This is true to a certain extent. If, however, this were the only field of the chemical engineer, the number of chemical engineers required would be only such as to staff the equipment industry, and there would be no particular place for the chemical engineer in the process industries. On the other hand, everyone who has had any contact with a plant knows that it is one thing to put in a piece of apparatus and something else to keep it operating properly and efficiently. This is the principal field of the chemical engineer, a more important field than the designing of the equipment in the first place. A thorough understanding of the unit operations leads often to a much better understanding of how the equipment may be operated and what changes in operating conditions will do to change its capacity or economy. It is here that the chemical engineer finds his largest field of activity.

A second field of activity for the chemical engineer is to act as a liaison officer between the development laboratory and the plant. When a chemical laboratory comes up with a new process or a new idea, that must be translated into actual physical equipment that somebody can run. While it is true that many chemists after long experience in industry are able to do this, it is much more logical to turn it over at once to a man whose whole training has been to devise equipment in which to carry out certain operations. He may find a large part of the equipment from standard equipment manufacturers. He very often has to design something specific. The chemical engineer has the advantage over a man with strictly mechanical engineering training in that he is familiar with the chemistry of the process in which he is working and can take this into account in planning the equipment and its operation.

The result of this is that in many cases the chemical engineer's widest field of activity has developed one step beyond the ideas in the last paragraph, and he becomes a man who is in charge of operations. Here his knowledge of the equipment plus his knowledge of the chemistry of the process makes him the most suitable man for an operating job. In this discussion, of course, I am sticking to the strictly technical aspects of this training, leaving out all such considerations as his being able to get along with people, being able to handle labor, and so on. These latter are conditions that must be met by any man who fills these jobs, no matter what his technical background is.

THEORY AND PRACTICE

One of the criticisms that is often made in plants when a new chemical engineer comes in fairly fresh from college is that he is not practical. This is a criticism that can be fairly leveled at most young college graduates. After all, the university is only supposed to teach them half their job—theory, and the practice must be accumulated by experience. There is no other way. This is true whether the man be a chemical engineer or mechanical engineer or any other type of engineer. An illustration of the difference between theory and practice comes to my mind.

When I was teaching in the University, one of the problems I used to give the boys was to design the head for a pressure vessel of a given diameter and carrying a given pressure on the inside. The boys had had the formulas for flange thickness, bolt circles, and so on, and they wound up with a flange of a certain diameter and a certain thickness and with a load of so many pounds that must be carried by the bolts. So far, theory stayed with them. The next step was one that depended on experience. The question was how many bolts, how big, should be used? I remember that in the problem that I gave them I got results all the way from four $2^1/_2$-inch bolts to some ninety-six $^1/_4$-inch bolts. The boys always wanted to know, "How do you know which to use?" and the answer of course is that you can't know until you have handled such problems in practice. As I recall it, the vessel was about 30 inches in diameter. With four heavy bolts, the flange would spring between bolts and would not be tight. With ninety-six $^1/_4$-inch bolts, the average mechanic would pull the bolts in two trying to tighten them. The actual answer as I recall it came out about sixteen $^3/_4$-inch bolts.

This is the sort of thing that no one can teach in classes and that must be accumulated by actual experience. And actual experience unfortunately too often consists in making mistakes and then finding out afterward why the mistake was made. However, most of us who lay any claim to practical experience and a feeling for what will work and what won't work in the plant, if we are honest, will have to admit that we got to that point by making a great many mistakes, some of which fortunately never were found out.

INSTRUMENTATION

One of the aspects of the chemical engineer's work not often realized is that, through his understanding of factors that control the operation of the equipment he is building, he has a better understanding of how instrumentation can be applied in order to minimize labor. One often sees overinstrumented equipment where instruments are put in to control factors that do not need to be controlled. It is true that fairly often we instru-

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ment a piece of equipment or a process for the purpose of learning more about it and not with the idea that every instrument is to be concerned solely with practical routine control. This is one of the ways in which our knowledge of the unit operations progresses, to have detailed records of many factors about an operation, so that, in the course of time, they can be interpreted into a better understanding of it.

On the other hand, instrumentation can be and should be used also to decrease the amount of labor. One instance came up in my own experience. I had designed a caustic evaporating and finishing plant out on the West Coast and I had had to crowd a great deal of equipment into one building. We had in that one building a triple effect evaporator, three double effects, three single effects, three rotary vacuum filters, four rotary pressure filters, a large vacuum cooler, various sections of a Swenson-Walker cooler, and about 70 transfer pumps. A British engineer who was interested in the same type of plant wanted to see this installation. It happened that we reached the plant at about 11:30 and went up to the evaporator building at once. This particular building was arranged with a long central aisle, and all the equipment was on mezzanines around it, so that when one stepped in the door he could see practically everything in the building. We stepped in and my British friend looked around and said, "But isn't it a bit unusual for you to let the entire crew go out for lunch at once?" I said, "Nobody's gone to lunch." He said, "Where are the operators?" I said, "There aren't any operators." He said, "You don't mean that all this apparatus is automatic," and I said, "Yes, it's all automatic." So I took him through the entire plant, which happened on that particular day to be running at about 125% of its rated capacity. We went upstairs and downstairs and saw every piece of equipment and never saw a man. Finally, at the end of the trip I took him to one back corner where there was one man sitting with his feet on a desk in front of an instrument panel. I told him that that man was the only man who was ever in that building unless he chose to send for the master mechanic's crew, and that he ran the entire process, everything in the building. The Englishman couldn't understand. He said that in a British plant of that sort there would be between 75 and 100 operators.

Now this instance I cite not so much to show the difference between English practice and American practice as to point out that what we had accomplished there in the United States that had not been accomplished in England was due to the fact that the chemical engineer has been recognized for 35 years at least in this country. In England, although there are schools that turn out what they call chemical engineers, actually such men have specialized in industrial chemistry. They are laboratory men, or else they are pure theorists interested only in writing differential equations.

THE CHEMICAL ENGINEER IN THE PAPER INDUSTRY

Now with regard to the use of the chemical engineer in the paper industry, I am leaving that to you, rather than trying to give you any specific instances of what he could do. You all carry out many of the operations of chemical engineering, the heating of liquids, the absorbing of gases, the extraction of solids by liquids, the separation of solids from liquids by filtration, evaporation, and many others. You possibly think of your own problems in the paper industry as being altogether different from anybody else's problems, but nevertheless it follows that a thorough understanding of the basic principles of these unit operations is just as valuable in your industry as in any other. Any man who thoroughly understands the principles back of the design of the equipment, the principles on which it operates, the effect of the control or variation of certain factors in the operation on its capacity and economy has as much value in the manufacture of pulp or the manufacture of paper as in any other industry where the same operations appear.

If I were to sum up in a few words what a chemical engineer is and what he is supposed to do, I would say first, that he is an engineer; second, that he differs from most other engineers in two factors: (1) he has a thorough background of chemistry and is able to understand the chemistry of the processes in which he works, and (2) he has a thorough knowledge of the unit operations which are the tools by which such a process is carried out. The logical consequence of being thoroughly acquainted with the unit operations is that all the other things that the chemical engineer does, such as acting as liaison between development and plant, selecting and operating equipment, and finally taking charge of the operation of whole processes, follows directly.

RECEIVED April 26, 1951. Presented at the annual meeting of the Technical Association of the Pulp and Paper Industry, New York, N. Y., Feb. 19–22, 1951.

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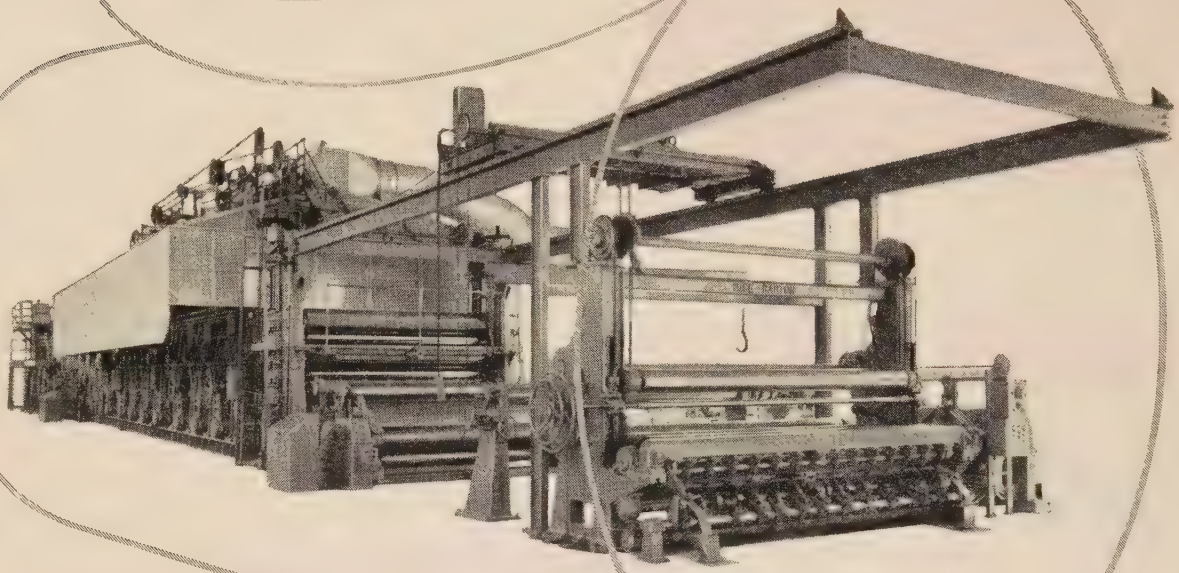

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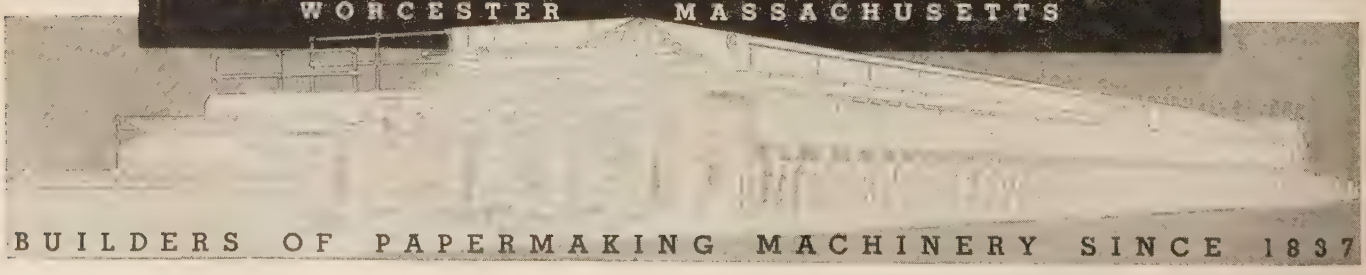

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PULP, PAPER, AND PAPERBOARD IN THE UNITED STATES*

Review for 1950

Economic Review

The year 1950 shattered all previous records in the pulp, paper, and paperboard industry. Whether it be in the field of pulpwood consumption, wood pulp production, wood pulp consumption, waste paper consumption, or paper and board production, the 1950 volume exceeded the level of 1939 by approximately 100%. For a short span of 10 years these are indeed remarkable achievements.

Pulp, Paper, and Board Highlights

Item	*Unit, millions of*	*1950*	*1949*	*1948*	*1947*	*1939*
Pulpwood consumption	Cords	23.7	19.9	21.2	19.7	10.8
Wood pulp production	Tons	14.8	12.2	12.9	11.9	7.0
Wood pulp consumption[a]	Tons	16.5	13.6	14.3	13.3	8.7
Waste paper consumption[a]	Tons	7.9	6.6	7.6	8.0	4.4
Paper and board production	Tons	24.3	20.3	21.9	21.1	13.5
Wood pulp imports[b]	Tons	2.4	1.8	2.2	2.3	2.0
Newsprint imports	Tons	4.9	4.6	4.4	4.0	2.6

[a] In manufacture of paper and board only.
[b] Includes rayon and other nonpaper grade pulp.
Source: Bureau of Census, U. S. Department of Commerce.

In measuring the activity of the industry in terms of the total value of sales of pulp, paper, board and products, the year 1950 recorded a new high of 6.8 billion dollars compared with only $1.8 billion in 1939. These dollar values are in terms of "current" dollars and thereby reflect, in part, the inflation of the dollar. Nevertheless, as indicated in other tables, the volume of both production and sales of the products of the industry has about doubled.

Total Value of Sales of the Pulp, Paper, Board and Products Manufacturing Industry

Year	*Millions of dollars*	*Year*	*Millions of dollars*	*Year*	*Millions of dollars*
1939	1785	1943	3389	1947	5763
1940	2064	1944	3629	1948	6066
1941	2836	1945	3725	1949	5511
1942	2965	1946	4467	1950[a]	6776

[a] Preliminary.
Source: Office of Business Economics, Department of Commerce. The estimated dollar total of sales represents receipts of all operators of paper manufacturing companies. The figures include data for both corporate and noncorporate businesses, but are comparable to the sales data for corporations in *Statistics of Income* published by the Bureau of Internal Revenue.

The industry continues to be a predominant factor in the foreign trade of the United States. Here again all previous records in terms of value of imports of pulpwood, wood pulp, paper, and manufacturers were broken with the value of imports in 1950 of 746 million dollars compared with $215 million in 1939. While exports in 1950, at 107 million dollars, were less than in recent years, they nevertheless exceeded 1939 by 67 million dollars.

Total United States Imports and Exports Paper Base Stocks, Paper, and Manufactures
(Millions of Dollars)

Year	*Imports*	*Exports*	*Year*	*Imports*	*Exports*
1939	215	40	1948	754	139
1945	298	102	1949	666	113
1946	419	116	1950[a]	746	107
1947	657	173			

[a] Preliminary.
Source: Bureau of the Census, U. S. Department of Commerce.

Annual Value of Sales of United States Wholesale Distributors of Paper and Its Products, 1939–50

Year	*Millions of dollars*	*Year*	*Millions of dollars*	*Year*	*Millions of dollars*
1939	575	1943	801	1947	1625
1940	595	1944	835	1948	1575
1941	750	1945	866	1949	1437
1942	752	1946	1338	1950[a]	1686

[a] Preliminary

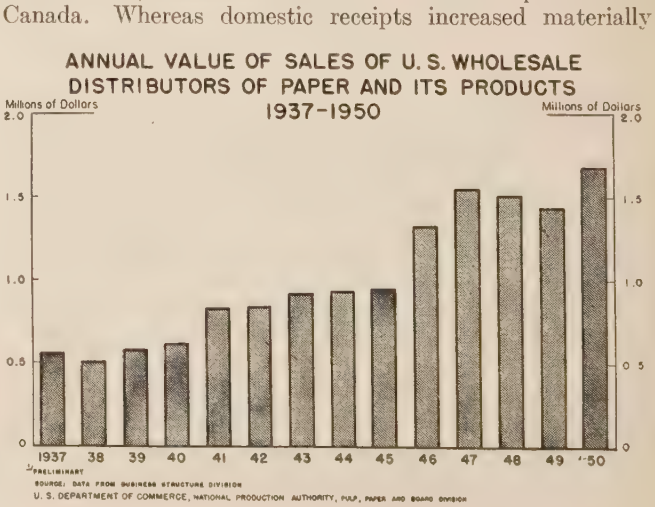
Monthly Value of Sales of United States Wholesale Distributors of Paper and Its Products, 1946–50
(Millions of Dollars)

Month	*1946*	*1947*	*1948*	*1949*	*1950*
January	90	134	139	121	124
February	81	118	128	111	115
March	94	125	134	122	127
April	101	132	131	115	120
May	112	130	123	109	124
June	113	134	132	116	136
July	112	128	117	105	128
August	125	130	134	128	163
September	128	153	137	127	156
October	140	165	139	129	172
November	125	137	134	130	164
December	117	139	127	124	157
Total	1338	1625	1575	1437	1686[a]

[a] Preliminary.
Source: Prepared by Pulp, Paper and Board Division, National Production Authority, from data supplied by Business Structure Division, U. S. Department of Commerce.

Pulpwood

United States receipts of pulpwood in 1950 totaled 22.6 million cords, of which 1.9 million cords were imported from Canada. Whereas domestic receipts increased materially


ANNUAL VALUE OF SALES OF U. S. WHOLESALE DISTRIBUTORS OF PAPER AND ITS PRODUCTS
1937-1950
Millions of Dollars
Millions of Dollars
2.0
1.5
1.0
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0
1937 38 39 40 41 42 43 44 45 46 47 48 49 '50
PRELIMINARY
SOURCE: DATA FROM BUSINESS STRUCTURE DIVISION
U. S. DEPARTMENT OF COMMERCE, NATIONAL PRODUCTION AUTHORITY, PULP, PAPER AND BOARD DIVISION

* Prepared by W. LeRoy Neubrech, Chief, Pulp and Paper Section, U. S. Dept. of Commerce, Washington, D. C.

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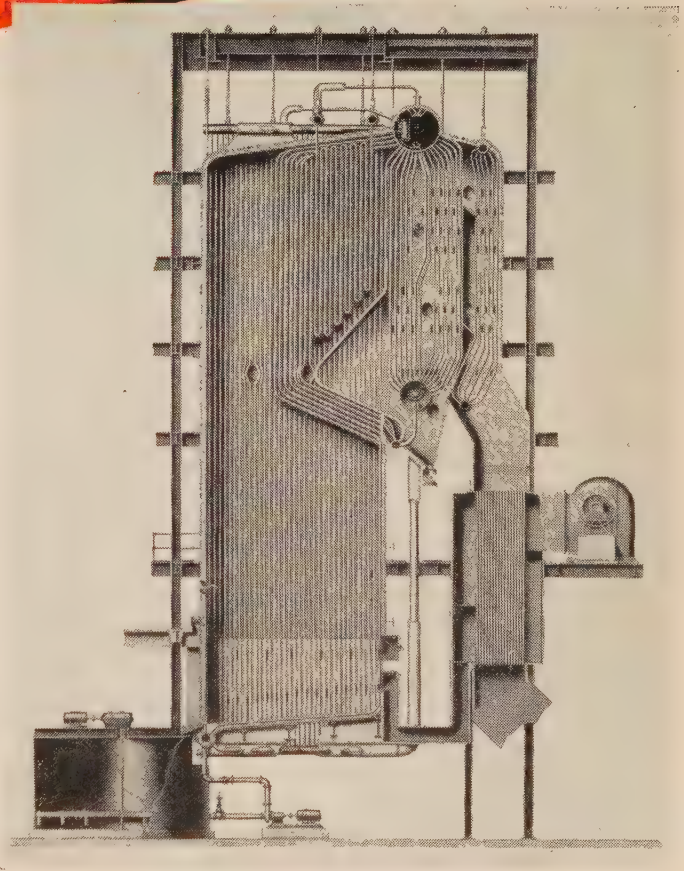


Typical B&W Black Liquor Recovery Unit.

BABCOCK & WILCOX

P-762

Pulpwood—United States Annual Receipts, Imports, Consumption, and Inventories

(1000 Standard Cords—Roughwood Basis)

	1950[a]	1949	1948	1947	1946	1945	1944	1943	1942	1941
Receipts:										
United States, total	22,556	19,252	22,333	20,619	18,978	16,983	16,998	15,293	17,140	16,458
Domestic	20,701	17,547	20,026	18,543	16,980	15,254	15,349	13,581	14,908	14,177
Imported	1,853	1,706	2,307	2,076	1,997	1,729	1,650	1,712	2,232	2,281
Northeast, total	3,305	3,325	4,039	4,135	3,650	3,389	3,039	2,954	3,399	3,486
Domestic	2,241	2,321	2,666	2,970	2,508	2,311	1,976	1,906	2,238	2,252
Imported	1,064	1,004	1,373	1,165	1,142	1,078	1,063	1,047	1,161	1,235
Appalachian, total	1,708	1,548	1,784	1,623	1,716	1,388	1,482	1,303	1,475	1,412
Domestic	1,708	1,548	1,763	1,610	1,684	1,365	1,472	1,302	1,448	1,378
Imported	...	...	21	13	32	23	10	2	27	34
South, total	11,541	9,057	9,997	8,227	7,909	7,153	7,090	6,505	6,622	6,400
Domestic	11,541	9,057	9,997	8,227	7,909	7,153	7,090	6,505	6,622	6,400
Imported	...	...	...	...	...	...	...	...	...	...
Lake States, total	2,483	2,160	3,031	2,900	2,919	2,456	2,637	1,969	2,796	2,241
Domestic	1,985	1,609	2,344	2,154	2,239	1,954	2,175	1,409	1,983	1,561
Imported	498	552	687	746	680	502	463	560	813	680
Pacific Northwest, total[b]	3,516	3,162	3,482	3,734	2,784	2,596	2,750	2,561	2,948	2,918
Domestic	3,226	3,015	3,256	3,581	2,642	2,470	2,636	2,458	2,616	2,585
Imported	289	148	226	153	142	126	114	103	231	332
Consumption, total[c]	23,656	19,945	21,189	19,714	17,818	16,912	16,754	15,645	17,275	16,580
Northeast	3,707	3,395	3,814	3,740	3,466	3,245	3,159	3,265	3,530	3,515
Appalachian	1,798	1,614	1,767	1,684	1,501	1,444	1,490	1,442	1,498	1,420
South	11,496	9,251	9,443	8,395	7,516	7,208	7,153	6,342	6,804	6,227
Lake States	2,827	2,459	2,821	2,724	2,554	2,544	2,474	2,325	2,471	2,398
Pacific Northwest[b]	3,828	3,199	3,344	3,171	2,781	2,472	2,482	2,271	2,972	3,019
Inventories, total[d]	3,813	4,877	5,622	4,566	3,780	2,627	2,819	2,846	3,392	3,729
Northeast	1,069	1,526	1,644	1,442	1,063	869	700	820	1,119	1,218
Appalachian	250	335	397	372	422	206	279	280	423	439
South	747	670	828	291	526	145	218	293	126	334
Lake States	992	1,315	1,674	1,486	1,350	986	1,088	962	1,313	995
Pacific Northwest[b]	755	1,031	1,079	974	419	420	534	491	410	742

[a] Preliminary.
[b] Converted 600 board feet equal 1 cord.
[c] Total consumption for 1940 was 13,743,000 cords; for 1939 it was 10,816,000 cords.
[d] End of year.
Note: Detail may not add to totals because of rounding.
Sources: Prepared by Pulp, Paper and Board Division, National Production Authority: data covering 1939, 1940, and 1945–50, inclusive—Bureau of the Census, U. S. Department of Commerce; data covering 1941–44, inclusive—Forest Products Bureau, War Production Board.

over previous years, imports were about 450 thousand cords less than in earlier years, such as 1941–42 and 1948. It is obvious that our own domestic forests are supplying an ever-increasing quantity of pulpwood for the manufacture of pulp in the United States. The most spectacular gain in pulpwood production has been in the Southern region where receipts have increased nearly 100% in the past decade, reaching a total of 11.5 million cords in 1950, currently amounting to approximately one half of total United States receipts from all sources, including imports.

Consumption of pulpwood in 1950 was somewhat more than 1 million cords greater than receipts, the net result being an over-all decrease in inventories during the year of approximately 1 million cords. It is reported, however, that the pulpwood cut in the northern regions of the Lake States, the New England areas, as well as in Canada, during the winter of 1950–51, has probably established an all-time record so that the northern mills may expect to have an adequate supply of pulpwood for the 1951 operating period.

In the South, and to a substantial degree on the West

Wood Pulp—United States Annual Imports and Exports, 1940–50

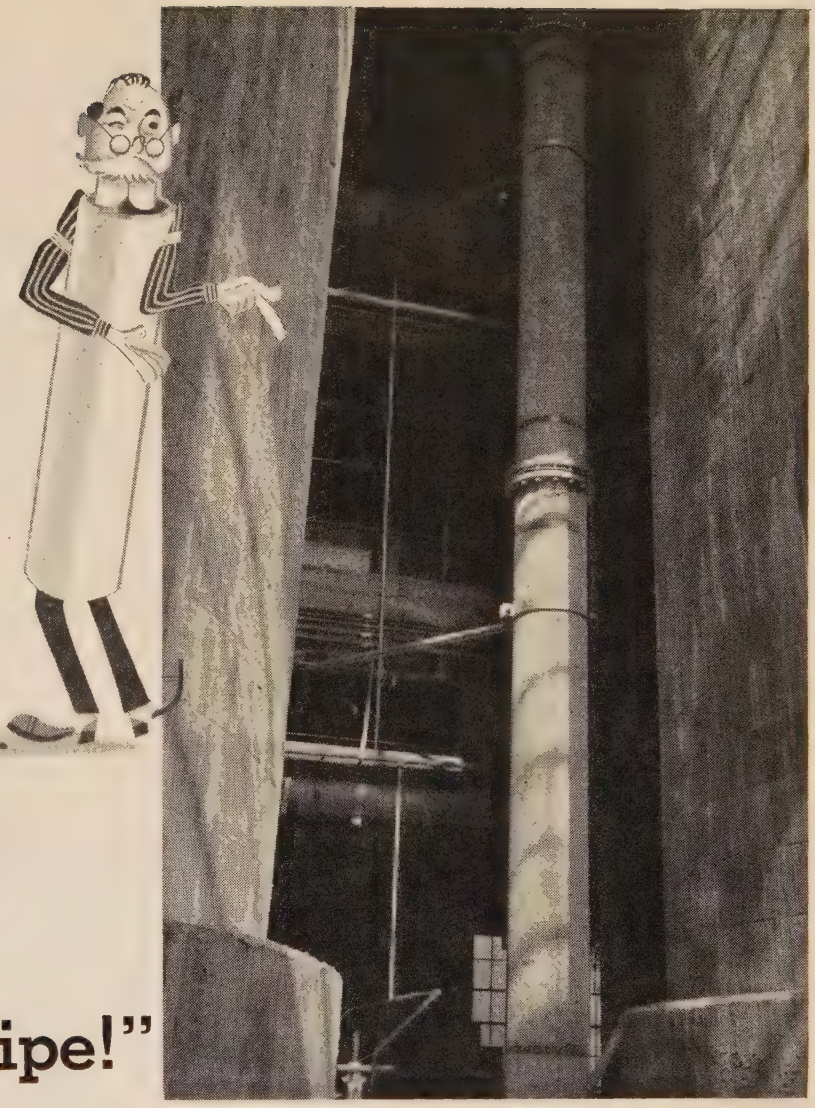
(1000 Short Tons)

Item	1950[a]	1949	1948	1947	1946	1945	1944	1943	1942	1940
Imports, total	2,376	1,763	2,176	2,295	1,795	1,752	1,072	1,306	1,237	1,225
Bleached sulphite: Rayon and special chemical grades	239	154	244	248	202	144	131	129	134	114
Bleached sulphite: Other	402	331	317	289	223	242	189	231	241	239
Unbleached sulphite	527	392	673	731	619	657	399	519	459	373
Bleached sulphate	444	392	278	239	80	72	47	48	58	85
Unbleached sulphate	438	249	336	468	398	380	99	105	91	224
Soda	34	27	25	21	20	21	16	20	18	11
Chemical screenings	5	3	8	10	9	7	7	11	8	8
Bleached mechanical	21	1	...	...	1	1	[b]	...	[b]	...
Unbleached mechanical	260	208	290	286	238	222	177	236	220	171
Mechanical screenings	6	6	5	5	6	5	5	6	7	[b]
Exports, total	96	122	93	130	39	136	218	301	378	481
Bleached sulphite: Rayon and special chemical grades	28	25	16	11	8	13	11	23	29	115
Bleached sulphite: Other	18	20	15	44	7	17	38	45	78	102
Unbleached sulphite	33	39	53	54	17	27	46	90	98	72
Bleached sulphate	5	9	1	2	1	6	7	16	28	18
Unbleached sulphate	9	27	6	17	5	60	106	121	140	159
Soda	[b]	[b]	1	1	[b]	11	11	5	3	10
Screenings and other wood pulp	2	1	1	2	1	2	[b]	1	1	4

[a] Preliminary.
[b] Less than 500 tons.
Note: Detail may not add to totals because of rounding.
Source: Prepared by Pulp, Paper and Board Division, National Production Authority, based upon data from the Bureau of the Census, U. S. Department of Commerce.

Pipe-fitter Pete says:

"If you want process lines that won't discolor paper stock... require little maintenance...



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Johns-Manville TRANSITE PRESSURE PIPE

Total United States Annual Wood Pulp Imports All Grades—By Major Countries of Origin

(1000 Short Tons)

Country	1939	1940	1941	1945	1946	1947	1948	1949[a]	1950[b]
Total	2026	1225	1158	1754	1795	2295	2176	1763	2376
Canada[c]	638	828	1145	1082	1234	1505[d]	1601[e]	1314	1711
Sweden	873	279	...	672	445	556	385	267	397
Finland	337	93	13	...	115	220	176	149	205
Norway	96	17	...	...	...	10	13	29	30
All other	82	8	...	...	...	5[f]	2[g]	5[h]	34[i]

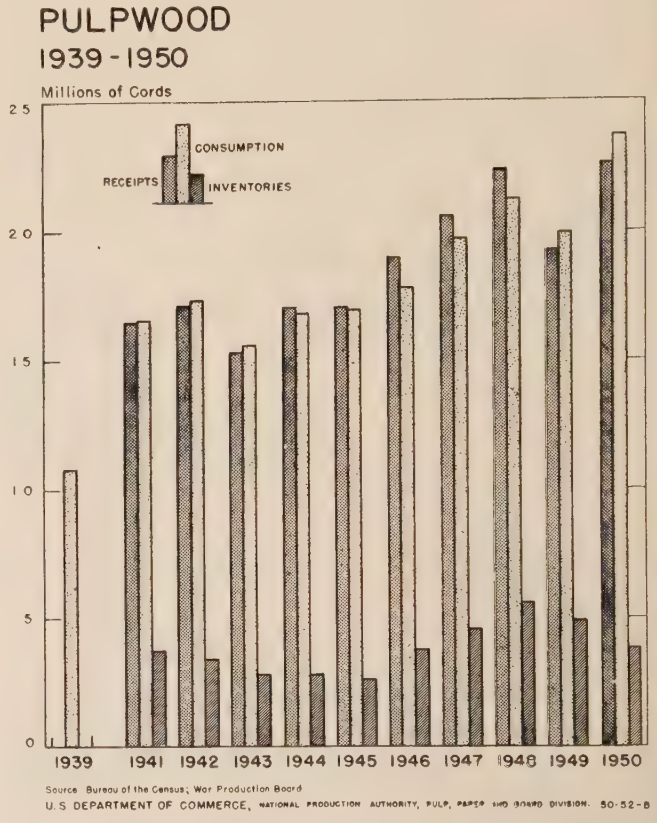
[a] Revised.
[b] Preliminary.
[c] Includes Newfoundland.
[d] Newfoundland—7854 tons.
[e] Newfoundland—7137 tons.
[f] U.S.S.R.—4928 tons.
[g] All from Austria.
[h] Austria—4459; Czechoslovakia—973.
[i] Austria—20303; Czechoslovakia—2597; Germany—957; and U.S.S.R.—9773.
Note: Detail may not add to totals because of rounding.
Source: Prepared by Pulp, Paper and Board Division, National Production Authority, based upon data from the Bureau of the Census, U. S. Department of Commerce.

Coast, where logging is conducted throughout the year, there is concern that the tightening supply of labor, as well as the possibility of shortages in logging equipment, trucks, and related items, could possibly make it more difficult to maintain full and adequate supplies of wood during the coming months of 1951. In fact, because of the high level of consumption, especially in the South, many pulp mills have found it hard to maintain desirable inventories of wood. Any unusual circumstance, such as prolonged wet spring weather, could in itself handicap the production of pulpwood at many mills in the deep south.

Wood Pulp

The subject of wood pulp continues to hold the spotlight in the industry. Although 1950 domestic production, at an all-time high of 14.8 million tons, coupled with record imports (except 1937) of 2.4 million tons, created a new peak in total supply, consumption exceeded supply with a moderate decrease of inventories during the year.

Consumption of pulp at paper and board mills alone in 1950 totaled 16.5 million tons with inventories at pulp,



Wood Pulp—United States Annual Production and Domestic Consumption, 1939–50

(1000 Short Tons)

Item	1950[a]	1949	1948	1947	1946	1945	1944	1943	1942	1941	1939
Production, total	14,827	12,172	12,872	11,946	10,607	10,167	10,108	9,680	10,783	10,375	6,993
Sulphite, total	2,856	2,536	2,811	2,796	2,476	2,360	2,386	2,437	2,930	2,919	1,946
Bleached	2,111	1,829	1,909	1,902	1,692	1,544	1,523	1,553	1,717	1,703	1,217
Unbleached	744	707	902	894	784	816	863	883	1,213	1,216	729
Sulphate, total	7,508	5,977	6,014	5,357	4,588	4,472	4,549	4,236	4,738	4,527	2,963
Bleached	1,422	1,118	1,040	909	750	705	665	602	653	659	424
Semibleached	375	264	225	193	152	149	144	147	159	164	[b]
Unbleached	5,711	4,595	4,749	4,255	3,686	3,618	3,740	3,487	3,927	3,704	2,538
Soda	523	492	510	492	476	430	413	419	462	480	442
Groundwood	2,221	1,960	2,175	2,050	1,897	1,696	1,639	1,638	1,756	2,152	1,445[c]
Defibrated, exploded, etc.						691	663	627	520	365	[c]
Semichemical	1,719	1,206	1,362	1,252	1,169	519	459	324	377	298	198[c]
Screenings, damaged, etc.											
Consumption, total	16,487	13,606	14,347	13,252	12,092	10,825	10,502	10,635	11,038	11,364	8,650
Sulphite, total	3,332	3,012	3,334	3,229	3,144	2,583	2,519	2,892	3,079	3,348	2,913
Bleached	2,072	1,850	1,856	1,792	1,680	1,346	1,277	1,442	1,498	1,805	[b]
Unbleached	1,259	1,161	1,478	1,437	1,465	1,237	1,242	1,449	1,581	1,543	[b]
Sulphate, total	8,381	6,678	6,663	5,860	5,141	4,680	4,588	4,430	4,633	4,614	3,354
Bleached	1,844	1,484	1,305	1,068	833	756	714	683	667	696	[b]
Semibleached	404	277	251	199	184	168	156	163	164	208	[b]
Unbleached	6,132	4,916	5,107	4,594	4,124	3,756	3,719	3,584	3,802	3,710	[b]
Soda	564	526	521	520	492	440	418	456	469	515	516
Groundwood	2,484	2,184	2,448	2,328	2,133	1,905	1,830	1,855	1,926	2,219	1,749[c]
Defibrated, exploded, etc.			746			684	661	639	527	346	[c]
Semichemical	1,726	1,207	149	1,315	1,181	533	486	364	404	321	119[c]
Screenings, damaged, etc.			485								

[a] Preliminary.
[b] Not available.
[c] Data on "defibrated, etc." included in "groundwood" and "semichemical, off quality, screenings, and miscellaneous."
Note: Detail may not add to totals because of rounding.
Source: Prepared by Pulp, Paper and Board Division, National Production Authority, based upon data from Bureau of the Census, U. S. Department of Commerce.

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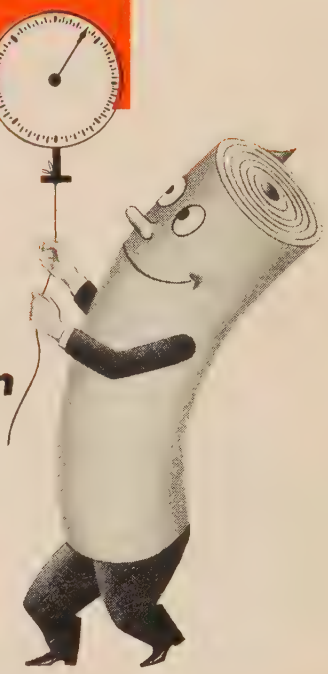

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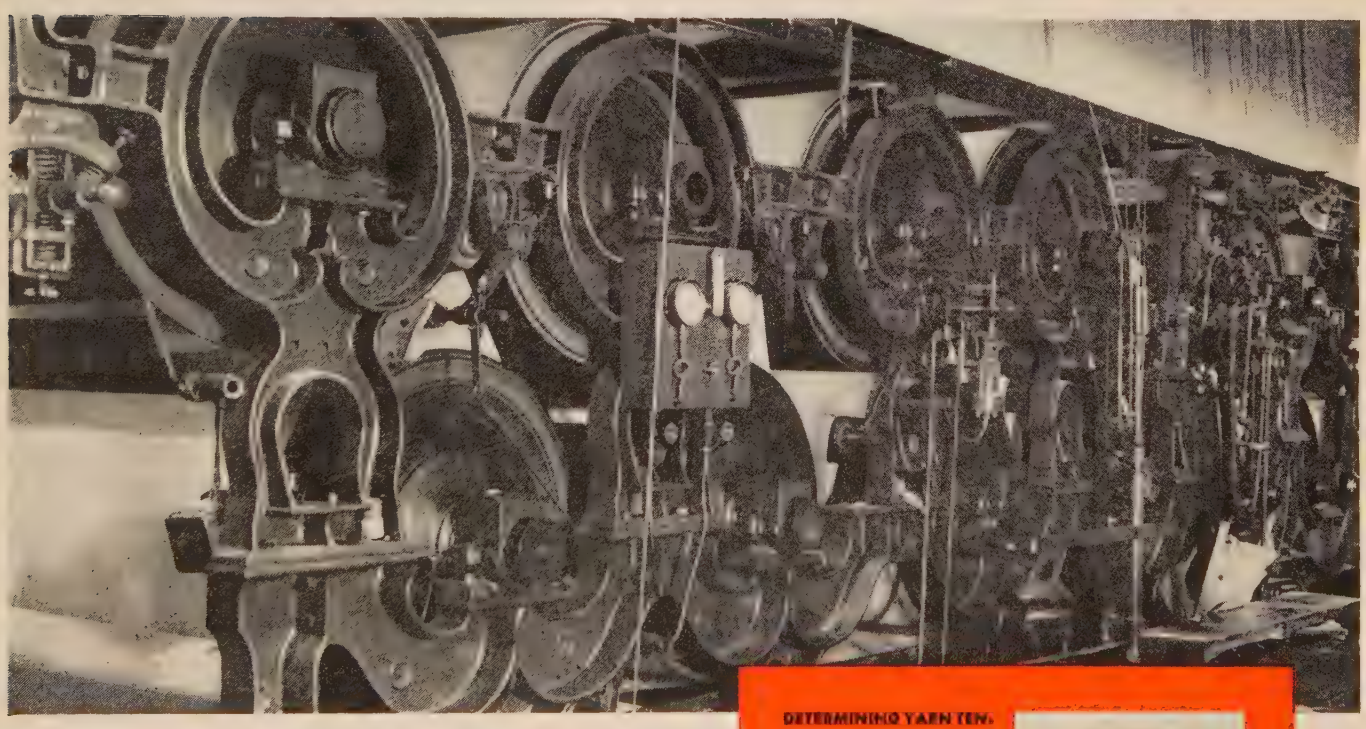

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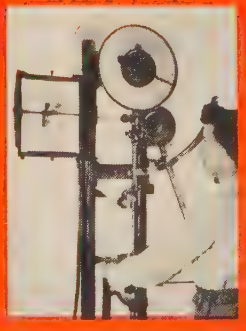


Wood Pulp—Year-End Inventories, 1941–50

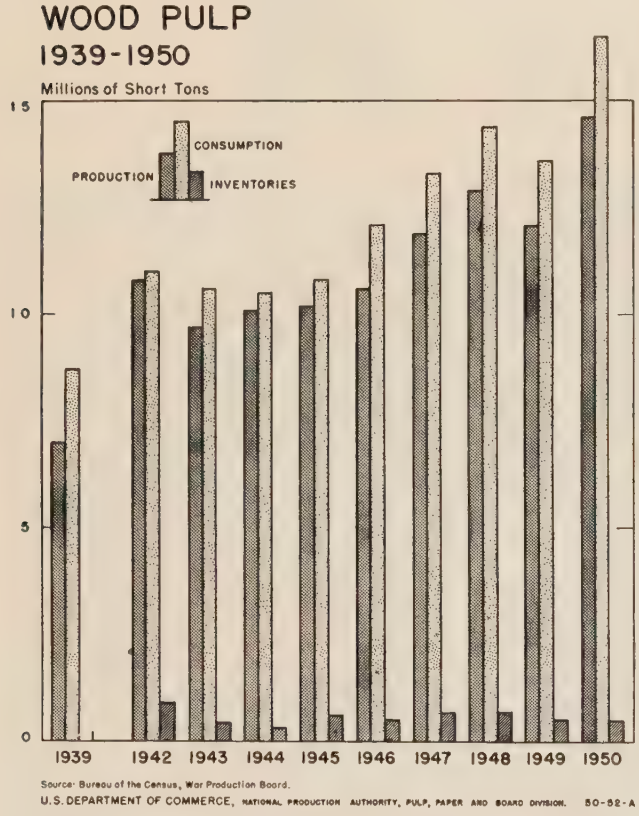
(1000 Short Tons)

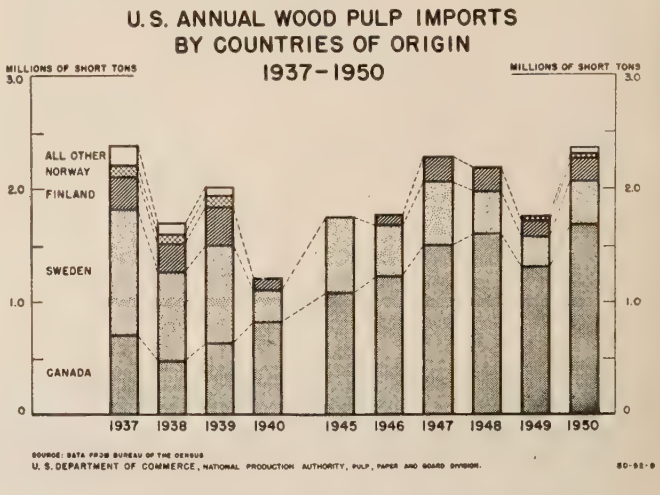
	1950[b]	1949	1948[a]	1947[a]	1946[a]	1945[a]	1944	1943	1942
Wood pulp, total	487	516	710	710	490	555	333	427	872
Sulphite, total	204	269	370	369	232	299	196	256	492
Bleached	98	131	157	163	107	127	152	184	287
Unbleached	106	138	213	206	125	173	44	72	205
Sulphate, total	196	149	226	244	176	179	66	67	238
Bleached	108	70	67	65	36	39	22	24	57
Semibleached	5	5	7	7	4	6	5	4	16
Unbleached	83	74	152	171	135	135	39	39	165
Soda	11	16	24	22	17	12	16	15	28
Groundwood	69	65	74	63	56	53	41	71	83
Miscellaneous	7	17	16	13	9	12	14	19	31

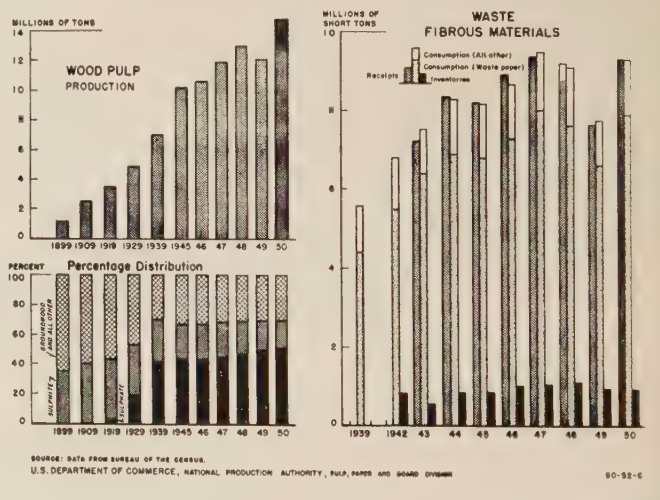
[a] Data for 1945, 1946, 1947, and 1948 are for pulp and paper mills only; data for other years also include wood pulp inventories held by companies outside the pulp and paper industry, e.g., pulp held by producers of explosives, rayon, molded products, etc.
[b] Preliminary data for December 31, subject to revision.
Source: Prepared by Pulp, Paper and Board Division, National Production Authority, based upon data from Bureau of the Census, U. S. Department of Commerce (figures for 1945–48); Forest Products Bureau, War Production Board (figures for 1941–44).

paper, and board mills declining from a level of over 700,000 tons at the end of 1948 to 487,000 tons at the end of 1950.

With reference to market wood pulp for paper and board mills, it is particularly significant that domestic and imported receipts in 1950 were at the high level of 2.9 million tons, with consumption approximately equaling receipts. Of total







Dissolving and Special Chemical Grades of Sulphite Pulp[a] in Other than Paper and Board Manufacture,[b] Last 6 Months 1950[c]

(Tons of 2000 Pounds)

Month	Receipts			Consumption	Month-end inventories
	Total	Domestic	Imports from North America[d]		
July	49,226	30,558	18,668	50,400	64,799
August	45,878	29,265	16,613	50,835	59,935
September	48,830	29,664	19,166	50,841	57,924
October	54,017	33,727	20,290	54,301	57,640
November	47,929	32,173	15,756	52,481	53,088
December	56,233	33,938	22,295	57,952	51,370
Total, July–December	302,113	189,325	112,788	316,810	344,756

[a] Includes a small quantity of other grades of wood pulp.
[b] Data not complete. Represent consumption of those plants that accounted for about 88% of the wood pulp consumed outside the paper and board industry in 1947. Include plants classified in the following industries: "Pulp goods, pressed and molded"; "Plastics materials"; "Synthetic fibers"; and "Explosives."
[c] Not available prior to July, 1950.
[d] Includes a slight amount of wood pulp produced outside North America.

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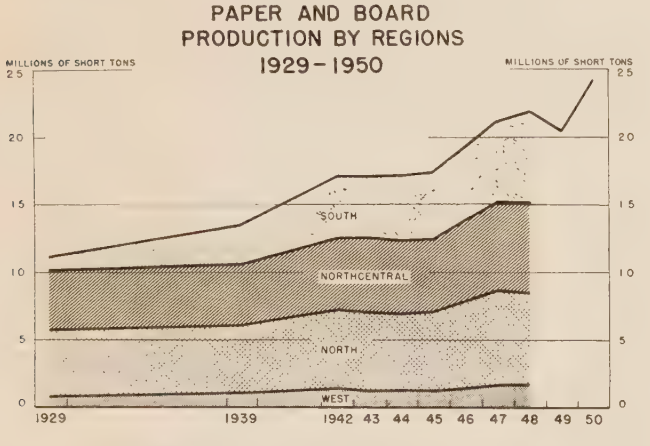
Market Wood Pulp[a]—Paper and Paperboard Mills Only—Annual Receipts, Consumption, and Inventories, 1947–50
(1000 Short Tons)

Item	*1950*	*1949*	*1948*	*1947*
Wood pulp, total all grades:				
Receipts, total	2910	2180	2448	2709
Domestic	1217	949	1058	1189
Imported	1694	1233	1489	1520
Canada and Newfoundland	970	723	901	784
European	728	507	589	736
Consumption (purchased pulp) total	2902	2356	2564	2511
Inventories (purchased pulp) total[b]	327	343	519	532
Domestic shipments, total[c]	1152	923	1014	1041
Sulphite, all grades:				
Receipts, total	1463	1205	1471	1552
Domestic	672	589	647	722
Imported	791	618	824	831
Canada and Newfoundland	480	370	524	492
European	313	246	299	341
Consumption, total	1485	1312	1453	1431
Inventories, total[b]	160	194	297	283
Domestic shipments[c]	657	595	641	654
Sulphate, all grades				
Receipts, total	1002	618	714	779
Domestic	326	192	200	260
Imported	675	428	515	522
Canada and Newfoundland	300	205	237	154
European	374	223	279	367
Consumption, total	973	673	720	729
Inventories, total[b]	118	103	158	188
Domestic shipments[c]	294	180	189	199
Groundwood and other grades:				
Receipts, total	446	355	362	375
Domestic	216	170	213	207
Imported	228	185	149	175
Canada and Newfoundland	187	148	137	138
European	41	38	10	30
Consumption, total	442	370	392	349
Inventories, total[b]	49	46	65	61
Domestic shipments[c]	201	151	183	186

[a] Market pulp consists of domestic or imported pulp purchased from a mill not under the same ownership control as the purchaser.
[b] End of year.
[c] Shipments by domestic pulp mills to domestic paper and paperboard mills. The difference between shipments and receipts may be explained in part by "in transit" pulp and probable incomplete reports on domestic shipments.
Detail may not add to totals because of rounding.
Note: Data on imports from Canada and Newfoundland also include shipments from all other North American countries, such as Mexico; data on imports from Europe also include shipments from all overseas sources.
Source: Prepared by Pulp, Paper, and Board Division, National Production Authority, based upon data from Bureau of the Census, U. S. Department of Commerce. Data for 1950 preliminary.



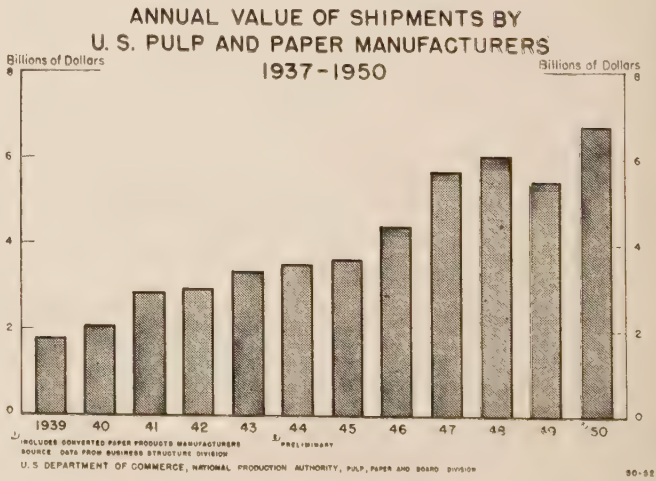
supplies of market pulp for paper and board mills in 1950, 1.7 million tons were imported from Canada and Europe. It is generally reported that at least part of the shipments from Europe in 1950 were made from pulp mill inventory stocks in Sweden, Finland, and Norway.

Consumption of dissolving grades of pulp, in other than paper and board manufacture, increased from a monthly level of around 50,800 tons in August and September to 58,000 tons in December, 1950. At the same time, inventories declined from 64,800 tons in July to 51,400 at the end of December. Annual 1950 consumption of dissolving pulp in this field was apparently about 600,000 tons. Requirements for nitration will add to over-all requirements for those grades of pulp in 1951.

Waste Fibrous Materials

Waste paper is the predominant waste fibrous material utilized by the industry. Whereas receipts of waste paper at mills in 1950, totaling 7.9 million, broke all previous records, consumption was slightly less than the former peak year of 1947 when 8 million tons were utilized. It is quite likely that during 1951 there will be a further increase in the utilization of waste paper as a supplemental fiber.

Receipts and consumption of rags in 1950 were at high levels but moderately below the recent peak year of 1947.



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Waste Fibrous Materials—United States Annual Receipts, Consumption, and Inventories

(1000 Short Tons)

Item	1950[a]	1949	1948	1947	1946	1945	1944[b]	1943[b]	1939
Receipts, total	9329	7682	9233	9434	8895	8195	8359	7224	[c]
Waste paper	7895	6467	7670	7875	7487	6824	6937	6067	[c]
Rags	440	374	417	445	427	392	431	401	[c]
Other	994	839	1146	1114	981	978	991	750	[c]
Consumption, total	9344	7815	9149	9535	8660	8143	8245	7564	5526
Waste paper	7904	6600	7649	8009	7278	6800	6859	6368	4366
Rags	442	382	425	462	403	414	428	426	468
Other	998	833	1075	1064	980	929	957	770	692
Inventories, total	963	994	1129	1087	1078	829	837	553	[c]
Waste paper	385	392	517	521	515	327	315	249	[c]
Rags	54	56	58	67	77	53	79	71	[c]
Other	524	546	554	499	486	460	443	213	[c]

[a] Preliminary.
[b] 1944 receipts and inventories and data for 1943 were reported by a few mills other than paper and paperboard mills. Data for the remaining years are for paper and paperboard mills only.
[c] Not available.
Source: Prepared by Pulp, Paper and Board Division, National Production Authority; based upon data from the Bureau of the Census, U. S. Department of Commerce, and Forest Products Bureau, War Production Board.

Paper and Paperboard

Paper and board production in the United States in 1950, although at a high level in the first 6 months, increased to practically full capacity operations in the last half of the year, resulting in an annual output of 24.3 million tons compared to the previous high of 21.9 million tons in 1948. It is generally estimated that under forced draft the United States industry could have produced close to 25.5 million tons in 1950, providing adequate raw materials and chemicals were available.

While production of paper continued upward in most grades, the most noteworthy gain in tonnage output for 1950 was in the production of board, especially container boards.

Paper and Paperboard—United States Production, 1939–50

(1000 Short Tons)

Type of Product	1950[a]	1949	1948	1947	1946	1945[b]	1944[b]	1943[b]	1942[b]	1939
All types	24,300	20,327	21,928	21,114	19,278	17,371	17,183	17,036	17,084	13,510
Paper, total	12,094	10,371	11,154	10,795	9,787	8,457	8,220	8,415	9,115	7,484
Newsprint	1,017	918	876	833	773	725	721	811	967	954
Groundwood	694	674	772	821	776	636	593	586	610	540
Printing	488[c]	481[c]	517	546	474	351	314	356	341	81
Converting and other	206[c]	193[c]	255	275	302	285	279	230	269	460
Book paper[d]	2,592	2,308	2,377	2,208	1,933	1,501	1,436	1,593	1,704	1,535
General printing	1,949[c]	1,759[c]	1,866	1,697	1,458	1,111	1,034	1,150	1,190	1,132
Converting	631[c]	531[c]	492	498	457	380	400	437	507	375
Other book paper	12[c]	18[c]	19	13	18	10	2	7	7	28
Fine paper	1,223	1,015	1,141	1,172	1,160	1,001	974	1,021	1,055	723
Writing paper	965[c]	789[c]	909	918	902	799	777	814	832	595
Cover and text	66[c]	62[c]	72	83	93	59	52	48	46	32
Bristols	97[c]	82[c]	88	87	97	79	84	99	109	79
Thin paper	81[c]	62[c]	73	73	65	60	58	54	59	17
Other fine paper	16[c]	20[c]	...	...	3	3	3	5	9	[e]
Coarse paper, total	3,383	2,765	3,027	2,903	2,690	2,403	2,314	2,262	2,526	2,168
Glassine, greaseproof and vegetable parchment	148[c]	122[c]	135	156	158	140	139	144	135	75[f]
Wrapping	868[c]	774[c]	733	667	763	715	650	687	955	1,061[g]
Bag paper	760[c]	655[c]	686	540	524	365	375	518	661	654[h]
Shipping sack	666[c]	470[c]	617	671	550	423	392	315	251	[e]
Converting	941[c]	744[c]	856	869	695	760	758	597	526	379
Special industrial paper	316	251	316	289	272	238	245	208	188	71
Sanitary paper	1,108	1,006	983	894	861	824	808	806	811	357
Tissue paper	241	187	205	195	184	157	158	163	171	291
Absorbent paper	105	86	107	100	103	89	90	88	65	122
Building paper and insulation	1,414	1,162	1,348	1,289	1,036	883	881	878	1,001	659
Other paper	...	...	...	...	...	...	...	...	16	64
Board, all types, total	12,206	9,956	10,775	10,409	9,490	8,914	8,963	8,620	7,969	6,025
Container board	5,646	4,681	5,079	4,944	4,315	4,131	4,228	4,088	3,755	3,361
Folding boxboard	2,368	2,084	2,200	2,257	2,317	2,092	2,116[i]	2,047[i]	1,712[i]	1,360[i]
Setup boxboard	641	617	596	595	521	721	750[j]	829[j]	997[j]	865[j]
Cardboard	77	83	87	92	89	71	70	64	54	59
Building board	1,259	839	1,270	1,072	956	895	1,087[k]	1,064[k]	1,052[k]	115
Wet machine board	144	125	134	150	138	112	130	121	86	[e]
Other board	2,071	1,527	1,409	1,300	1,154[l]	891	581	408	313	265

[a] Preliminary.
[b] Comparability of the 1941–45 data with statistics for earlier years is affected to some extent by the inclusion of statistics for a few companies not previously covered and by certain classification changes. Data prior to 1941 are reasonably comparable with later years, with the exception of tissue paper, building paper, and building board. (For further details see Census of Pulp Mills and of Paper and Paperboard Mills, 1942.)
[c] Estimated.
[d] Includes machine-coated for 1948, 1949, and 1950.
[e] Not shown separately.
[f] Includes no vegetable parchment.
[g] Includes some bag paper and special industrial paper.
[h] Includes shipping sack paper.
[i] Prior to 1945 includes all grades of bending board.
[j] Prior to 1945 includes all grades of nonbending board.
[k] Includes liner for gypsum and stock for laminated wallboard.
[l] Includes bending and nonbending board not for use in box plants.
Source: Prepared by Pulp, Paper and Board Division, National Production Authority, based upon data from Bureau of the Census, U. S. Department of Commerce.

Plagued by pitch?

...Control it with CELITE

If green wood is aggravating the problem of pitch control in your mill, here's a suggestion that may be of help:

Try adding about 1% of Celite* at the beaters. Many mill operators find this a practical and economical cure for pitch trouble.

Celite works like this: Its porous, absorbent, and minute particles coat the individual pitch particles and destroy their stickiness. The Celite-coated pitch particles pass through the system, becoming an integral part of the sheet. Machines stay clean . . . paper quality high . . . and the cost of the Celite used is largely recovered when the paper is sold.

Why not let a Celite engineer make on-the-spot recommendations for controlling pitch in your mill? He will also acquaint you with other important Celite advantages that may help you turn out better paper at lower cost. Just write to Johns-Manville, Box 290, New York 16, N. Y. In Canada, address Canadian Johns-Manville Co., Ltd., 199 Bay Street, Toronto, Ontario.

Yours for the asking—Bulletin FA-31A gives helpful information on how to control pitch with Celite. You can get your copy by writing to the address above.

This photomicrograph shows the minute, porous Celite particles which, by coating pitch, destroy its stickiness, and prevent build-up of agglomerates.

*Celite is Johns-Manville's registered trade mark for its diatomaceous silica products.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville CELITE PRODUCTS

FOR THE PAPER INDUSTRY

United States Imports of Pulpwood, Wood Pulp, Paper, Paperboard, and Paper Products

(In Short Tons, Except Where Otherwise Indicated)

Item	1939	1941	1943	1944	1945	1946	1947	1948	1949[a]	1950[a]
Pulpwood, total (in cords of 128 cu. ft.)	1,130,874	1,632,605	1,391,392	1,368,109	1,562,877	1,728,262	1,828,228	2,020,979	1,418,468	1,412,365
Rough	237,898	133,596	337,811	458,379	726,218	891,321	936,293	913,838	510,134	373,460
Peeled	821,186	1,463,929	957,915	808,501	757,478	755,213	820,359	1,010,993	791,325	884,781
Rossed	27,352	1,611	23,499	14,174	2,318	169	730	806	447	151
Chipped	44,438	33,469	72,167	87,055	76,863	81,559	70,846	95,342	116,562	153,973
Wood pulp, total	2,026,441	1,157,886	1,305,549	1,071,623	1,751,835	1,794,669	2,322,460	2,176,111	1,763,351	2,376,371
Bleached sulphite: Rayon and special chemical grades	88,052	121,130	129,379	131,407	143,802	202,192	248,606	235,481	154,195	238,846
Bleached sulphite: Other	386,057	270,394	231,291	189,273	242,424	222,653	288,559	322,830	331,288	401,804
Unbleached sulphite	661,193	361,397	519,190	399,418	657,297	618,571	731,648	674,707	392,222	527,505
Bleached sulphate	108,252	59,394	47,664	47,458	71,996	79,697	239,069	277,989	391,609	443,928
Unbleached sulphate	546,167	116,224	104,678	98,557	380,432	397,906	470,174	336,449	248,814	438,330
Soda pulp	8,952	15,864	20,181	16,404	21,157	19,740	21,203	24,843	27,315	33,947
Chemical screenings	[b]	9,055	10,751	7,193	7,309	8,583	9,552	8,275	3,163	4,695
Bleached mechanical groundwood	...	...	...	26	1,177	1,296	...	...	538	21,210
Unbleached mechanical groundwood	227,768	197,991	236,484	176,861	221,533	238,130	308,946	290,484	208,224	260,347
Mechanical groundwood screenings	[b]	6,437	5,931	5,026	4,708	5,901	4,703	4,553	5,983	5,759
Waste fibrous materials, total	116,625	106,039	62,761	68,902	75,417	66,128	80,924	102,845	72,055	131,282
Rags for paper stock	57,241	10,212	3,792	3,715	3,247	14,800	13,772	20,040	7,917	131,194
Other pulp—rag, straw, esparto, etc.	204	163	51	13	...	200	31	4	[c]	[c]
Other waste fibrous materials	59,180	95,664	58,918	65,174	72,170	51,128	67,121	82,801	64,138	88
Paper, paperboard, and paper products, total	2,687,484	3,123,490	2,720,906	2,576,277	2,753,211	3,625,422	4,121,655	4,580,932	4,751,229	5,004,434
Paper and paperboard, total	2,682,856	3,056,066	2,717,614	2,573,957	2,751,214	3,621,714	4,116,643	4,574,469	4,746,421	4,995,417
Paper, total	2,654,440	3,019,279	2,663,559	2,522,071	2,700,348	3,579,790	4,056,784	4,499,397	4,676,116	4,909,890
Newsprint	2,615,128	2,982,375	2,637,429	2,491,452	2,668,799	3,490,280	3,958,065	4,395,273	4,639,562	4,859,909
Printing paper, uncoated	13,408	28,474	23,329	27,246	29,655	81,037	74,401	83,380	28,281	35,278
Fine paper, total	9,808	2,741	637	389	397	441	682	626	583	1,085
Writing paper	380	128	62	102	70	46	90	120	37	115
Cover paper	...	...	10	...	[c]	1	[c]	2	[c]	[c]
Bristols	74	2	...	[c]	1	11	2	12	94	259
Thin paper	9,292	2,586	519	251	304	362	512	434	361	568
Other fine paper	62	25	46	36	22	21	78	58	91	143
Wrapping, bag, and converting paper, total	14,955	4,490	951	2,100	792	7,039	22,098	18,426	5,709	10,864
Greaseproof	223	4	3	6	3	40	71	33	15	1,130
Vegetable parchment	117	5	2	...	...	11	8	15	9	17
Kraft wrapping[d]	12,735	2,269	734	689	29	5,923	10,936	10,627	3,823	7,330
Wrapping, except kraft[d]	1,880	2,212	212	1,405	760	1,065	11,083	7,751	1,862	2,387
Tissue and crepe paper	55	76	131	84	105	114	923	1,283	1,402	593
Absorbent paper	542	287	43	54	34	19	47	102	122	108
Building paper	544	836	1,039	746	566	860	568	307	457	2,053
Paperboard, total	28,416	36,787	54,055	51,886	50,866	41,924	59,859	75,072	70,305	85,527
Kraft container board	10	275	2,297	475	...	...	...	611	...	29
Other container and boxboard	388	...	1,662	1	[c]	10	2,745	25	15	435
Other paperboard	12,083	12,593	20,152	20,973	21,731	13,692	24,306	44,503	48,204	55,050
Fiber insulation board	3,731	3,250	1,595	2,049	1,172	653	1,300	73	12	2,627
Wallboard	12,204	20,669	28,349	28,388	27,963	27,569	31,508	29,860	22,074	27,386
Paper products, total	4,628	67,424	3,292	2,320	1,997	3,708	5,012	6,463	4,808	9,017
Papeteries	57	4	20	3	4	36	46	38	69	138
Surface-coated papers	324	32	19	25	34	13	31	32	40	265
Uncoated papers, decorated or covered with a design, etc.	17	[c]	...	...	...	4	5	7	1	25
Wallpaper	241	144	30	27	77	1,285	1,435	1,259	1,365	2,638
Decalcomania paper	464	702	328	483	536	784	922	957	571	1,109
Boxes of paper, papier-mache, or paperboard (not covered or lined)	167	104	157	425	274	352	234	297	357	479
Boxes of paper, papier-mache, or wood (covered or lined)	145	68	22	46	49	71	16	27	44	67
Manufactures of papier-mache, n.s.p.f.	141	17	2	3	6	16	21	51	58	101
Manufactures of pulp, n.s.p.f.	16	28	43	36	49	48	65	52	51	90
Bags and articles of surface-coated, parchment, or similar papers	133	59	58	33	10	33	77	63	60	174
Albums, photograph, autograph, scrap, etc.	5	2	[c]	[c]	1	2	[c]	1	[c]	14
Envelopes	8	5	6	15	188	101	24	38	47	45
Jacquard designs	[c]	[c]	[c]	[c]	...	...	[c]	[c]	[c]	[c]
Gummed paper, n.s.p.f.	1	[c]	[c]	[c]	...	...	2	[c]	[c]	19
Tubes for holding yarn and thread	163	...	...	[c]	[c]	...	[c]	...	[c]	21
Wall pockets of paper, papier-mache, etc.	28	3	...	...	...	4	...	43	14	35
Ribbon flycatchers	273	8	117	56	106	77	103	9	...	115
Masks of paper, pulp or papier-mache	48	5	[c]	[c]	...	[c]	4	[c]	6	8
Reinforced or cloth-lined paper	6	...	1	...	...	...	...	[c]	[c]	[c]
Stencil paper, not mounted	31	1	3	[c]	[c]	...	[c]	[c]	1	2
Papers, n.s.p.f.	943	65,534	1,578	832	226	283	968	652	400	1,133
Manufactures of paper, n.e.s.	1,417	708	908	336	437	599	1,059	2,937	1,724	2,539

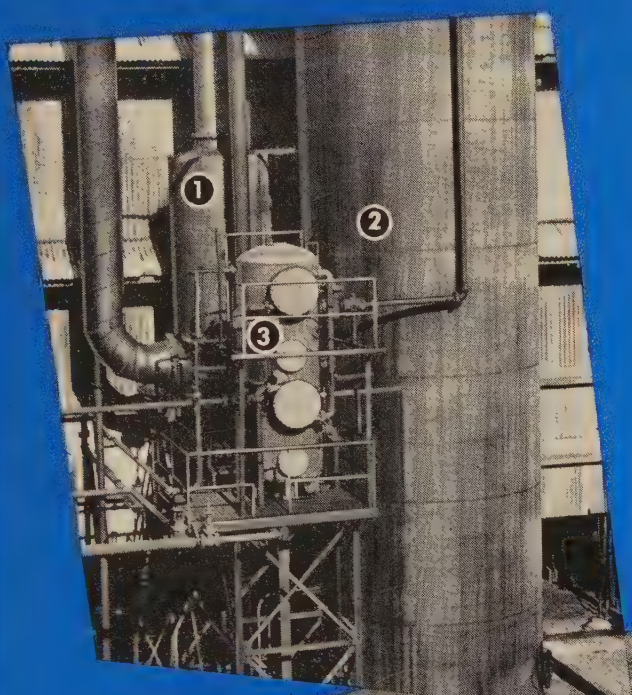
[a] Preliminary.
[b] Not shown separately.
[c] Less than one-half short ton.
[d] Includes bag paper.

Conversion factors derived from reported gross shipping weights: Stereotype matrix mat or board (included under absorbent paper)—1000 sq. in. = 1.43 lb.; papeteries—$500 = 1 ton. Boxes of paper, papier-mache, or paperboard (not covered or lined)—$140 = 1 ton. Manufactures of papier-mache, n.s.p.f.—$2240 = 1 ton. Manufactures of pulp, n.s.p.f.—$860 = 1 ton. Albums, photograph, autograph, scrap, etc.—$3060 = 1 ton. Jacquard designs on rule paper, etc.—$94,000 = 1 ton (price includes cost of die). Ribbon flycatchers—$840 = 1 ton. Masks of paper, pulp, etc.—$760 = 1 ton. Papers, n.s.p.f.—$80 = 1 ton. Manufacturers of paper, n.e.s.—$360 = 1 ton. Wall pockets of paper, papier-mache, etc.—10,000 wall pockets = 1 ton.

Source: Prepared by Pulp, Paper and Board Division, National Production Authority, based upon data from the Bureau of Census, U. S. Department of Commerce.

harnessing HEAT DOLLARS *at St. Regis*

with FOSTER WHEELER BLOWDOWN RECOVERY SYSTEMS



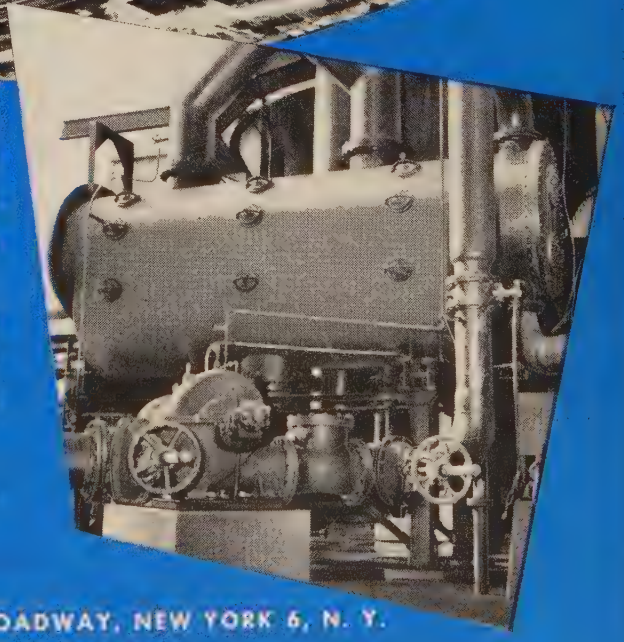
At the St. Regis Paper Mills in Pensacola, Florida, two types of blowdown recovery systems are in operation. In the Vapor-to-Liquid System *(left)* steam is condensed in the atmospheric condenser (1) and hot condensate is stored in the accumulator tank (2). This condensate, contaminated by some black liquor and pulp, is flashed under vacuum and the resultant clean vapors heat mill water in the tubes of the flash heater (3).

In the Surface Condenser *(below)* mill water flowing through the tubes is heated by steam condensing in the shell. The separator chamber at vapor inlet prevents pulp from reaching tube bundles.

Properly engineered recovery equipment not only *costs you less* in the long run but *increased operating efficiency* and *large fuel savings* may also be enjoyed from the outset.

If you are contemplating improvements at your mill, our specialists on pulp and paper mill equipment will be glad to help you with your engineering problems.

Foster Wheeler Blowdown Recovery Systems are discussed in the May, 1950 issue of *Heat Engineering*. Write for a copy!



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FOSTER WHEELER

United States Exports of Pulpwood, Wood Pulp, Paper, Paperboard, and Paper Products

(In Short Tons Except Where Otherwise Indicated)

Item	1939	1941	1943	1944	1945	1946	1947	1948	1949[a]	1950[a]
Pulpwood (in cords of 128 cu. ft.)	50,165	72,733	36,412	20,355	41,285	53,635	79,273	38,650	7,689	27,053
Wood pulp, total	139,504	328,608	300,700	218,412	135,997	39,361	130,096	93,782	122,153	95,693
Bleached sulphite: Rayon and special chemical grades	48,232	34,038	22,884	10,729	13,033	8,491	10,688	15,927	25,493	27,634
Bleached sulphite: Other	23,243	78,504	44,991	38,462	16,881	7,201	43,546	15,361	19,763	17,710
Unbleached sulphite	40,915	77,987	89,691	46,240	27,206	16,871	53,857	53,690	39,410	33,510
Bleached sulphate	[b]	10,474	16,344	6,697	5,633	778	2,187	716	9,542	4,709
Unbleached sulphate	14,816	118,588	120,552	105,673	60,482	4,663	17,332	6,165	27,234	9,555
Soda pulp	4,013	2,174	5,341	10,581	10,967	145	569	551	75	60
Screenings and other wood pulp	8,285[c]	6,843	897	30	1,795	1,212	1,917	1,372	636	2,515
Waste fibrous materials, total	148,051	139,378	26,102	12,647	21,908	86,315	163,106	169,682	125,308	126,874
Overissue news	85,635	91,057	5,542	919	375	14,587	30,883	23,080	74,265	68,495
Rags for paper stock: Valued $50 or over per ton	6,549	2,919	1,639	1,230	862	2,755	3,560	3,220	2,846[d]	2,751[d]
Rags for paper stock: Valued under $50 per ton	4,421	7,559	1,234	1,618	2,807	9,751	8,501	9,135	5,265[e]	4,422[e]
Other waste paper and paper stock	51,446	37,843	17,687	8,880	17,864	59,222	120,162	134,247	42,932	51,206
Paper, paperboard, and paper products, total	248,569	464,389	319,922	313,911	458,689	393,301	474,094	397,024	372,345	371,608
Paper and paperboard, total	197,903	399,245	254,709	253,603	396,198	305,051	352,464	295,143	296,251[f]	297,195
Paper, total	96,628	264,164	181,657	180,307	255,047	217,513	213,956	161,381	181,095[f]	175,170[g]
Newsprint	13,495	70,265	35,256	31,162	43,651	27,685	28,055	27,662	38,660	43,966
Book paper, uncoated	15,387	41,406	22,415	22,022	49,277	43,837	54,130	44,442	28,230	20,123
Fine paper, total	21,115	46,430	57,907	67,741	85,671	81,121	68,323	45,311	43,661[h]	38,548[h]
Writing paper	18,986	42,047	45,687	55,821	70,985	57,631	46,898	29,943	32,901	29,801
Cover paper	833	1,265	1,304	1,153	1,808	2,570	3,104	1,254	[i]	547
Bristols	1,296	2,553	3,866	4,057	5,099	5,691	6,051	5,197	1,034	1,071
Cigarette paper	[i]	565[j]	7,050	6,710	7,779	15,229	12,270	8,917	8,327	6,580
Wrapping bag, and converting paper, total	31,842	79,727	45,232	41,001	47,979	44,344	41,396	28,589	28,062	39,892
Greaseproof and waterproof paper[k]	4,620	9,746	17,374	17,886	18,702	13,939	13,734	8,500	3,297	3,843
Wrapping, except kraft[l]	17,608	44,137	12,628	12,280	15,986	19,846	15,109	9,164	7,113	7,486
Kraft wrapping[l]	9,614	25,844	15,230	10,835	13,291	10,559	12,553	10,925	17,652	28,563
Tissue and crepe paper[m]	6,447[n]	14,210[o]	11,776	11,170	10,257	7,207	8,428	4,927	10,084	7,433
Blotting paper	1,564	2,001	1,063	1,036	2,616	4,551	4,640	2,643	2,761	2,735
Sheathing and building paper	6,778	10,125	8,008	6,181	15,596	8,768	8,984	7,807	9,218	8,321
Paperboard, total	101,275	135,081	73,052	73,296	141,151	87,538	138,508	133,762	115,156[p]	122,025[p]
Kraft container board	42,742	34,598	23,046	31,003	38,166	23,859	47,866	51,983	49,804	53,155
Other container and boxboard	14,055	29,311	14,652	12,266	35,703	12,857	12,011	10,427	21,532	43
Other paperboard	16,474	41,760	25,511	17,404	21,983	24,270	37,502	35,756	19,269	12,161
Fiber insulation board	19,535	14,548	7,175	7,252	25,951	17,649	27,789	18,052	18,872	1,448
Wallboard	8,469	14,864	2,668	5,371	19,348	8,903	13,340	17,544	5,679	23,463
Paper products, total[q]	50,666	65,144	65,213	60,308	62,491	88,250	121,630	101,881	76,094	72,965
Surface-coated paper	7,076	10,346	9,151	16,445	13,178	16,008	22,091	12,509	[i]	[i]
Toilet paper	5,268	8,699	9,594	6,103	5,852	7,808	7,684	7,284	8,046	7,383
Paper towels and napkins	2,980	3,026	1,840	1,650	2,018	2,078	2,042	1,908	1,867	1,972
Filing folders, index cards, and other office forms	610	788	1,328	1,304	1,349	1,469	1,756	1,934	2,636	3,772
Papeteries	104	189	48	41	185	278	411	56	366	359
Wallpaper	668	729	339	290	757	1,077	636	91	205	206
Shipping sacks	2,609	4,371	5,324	5,604	8,796	9,355	21,459	22,826	5,716	10,128
Paper bags	6,563	6,259	4,443	2,955	3,711	5,742	9,630	6,898	10,293	7,101
Shipping containers	5,404	9,323	9,236	4,966	2,878	7,765	9,547	9,030	9,822	7,795
Boxes and cartons	4,283	3,235	7,417	3,756	2,195	4,500	6,988	5,200	5,365	5,247
Envelopes	539	729	570	585	742	1,283	1,217	863	700	502
Cash register and adding machine paper	2,755	829	1,517	1,404	1,163	2,007	4,459	4,113	[i]	[i]
Other paper and paper products	11,771	16,621	14,406	15,205	19,667	28,880	33,710	29,169	31,078	28,510

[a] Preliminary.
[b] Included under "other wood pulp."
[c] Includes bleached sulphate pulp.
[d] Valued at $100 or over per ton.
[e] Valued at under $100 per ton.
[f] Includes 7297 tons of uncoated and paper machine coated paper.
[g] Includes special industrial and coated printing and converting paper.
[h] Includes small quantity of miscellaneous thin paper and other fine paper not shown separately.
[i] Not shown separately.
[j] Figures for Nov. 11–Dec. 31, 1941, inclusive.
[k] Includes cellophane, glassine, vegetable parchment, etc.
[l] Includes bag paper and shipping sack paper.
[m] Includes thin paper other than cigarette, and sanitary paper, except toilet paper.
[n] Includes cigarette paper.
[o] Includes cigarette paper, Jan. 1–Nov. 10, 1941 inclusive.
[p] Total board including paperboard, building board and wet machine board.
[q] Does not include vulcanized fiber.

Conversion factors derived from reported gross shipping weights: fiber insulation board—1 sq. ft. = 0.87 lb.; wallboard—1 sq. ft. = 0.65 lb.; wallpaper—1 roll = 1.04 lb.; other paper and paper products—$380 = 1 ton.

Source: Prepared by Pulp, Paper and Board Division, National Production Authority, based upon data from the Bureau of the Census, U. S. Department of Commerce.

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Newsprint—United States Production, Imports, Exports, Domestic Consumption, and Inventories

(1000 Short Tons)

Item	*1950*[a]	*1949*	*1948*	*1947*	*1946*	*1945*	*1944*	*1943*	*1942*	*1939*
Production	1017	918	876	833	773	725	721	811	967	954
Imports	4860	4637	4395	3958	3492	2699	2491	2637	2921	2615
Re-exports[b]	n.a.	5	2	2	2	3	9	2	2	1
Exports	44	39	28	28	28	44	31	35	42	13
Total supply[c]	5833	5511	5241	4761	4235	3377	3172	3411	3845	3555
Inventories, total[c]	433	457	467	386	308	273	350	378	489	341
Publishers[d]	425	446	458	377	293	266	342	367	479	328
Mill	8	11	9	9	15	6	7	11	10	13
Change in stocks[e]	−24	−10	+81	+78	+35	−77	−28	−112	+96	+8
Apparent total consumption	5857	5531	5141	4753	4296	3481	3243	3627	3816	3546

[a] Preliminary.
[b] Re-exports of newsprint included in the general import statistics.
[c] Totals may not add because of rounding.
[d] Reported by 422 publishers of 525 newspapers consuming approximately 76.5% in 1950; 77% in 1949; 78% of the newsprint consumed in 1948; 75% in 1947; 73% in 1946; 70% in the first half and 71% in second half of 1945; 72.5% in 1944; and 75% in 1943.
[e] Compared with January 1.
n.a.—Not available.
Source: Production, import, and export figures, Bureau of the Census, U. S. Department of Commerce; consumption and publishers' inventories, American Newspaper Publishers' Association; mill inventories, News Print Service Bureau.

Production of Newsprint in North America

(1000 Short Tons)

Year	*Total*[a]	*United States*	*Canada*	*Newfoundland*	*Year*	*Total*[a]	*United States*	*Canada*	*Newfoundland*
1950[b]	6296	1017	5279[c]	[c]	1944	3985	721	2992	273
1949	6092	918	4732	444	1943	4030	811	2983	236
1948	5850	867	4601	382	1942	4422	967	3177	277
1947	5653	833	4447	373	1941	4815	1044	3426	345
1946	5279	773	4143	363	1940	4826	1056	3419	351
1945	4317	725	3259	333	1939	4129	954	2869	305

[a] Details may not add to total because of rounding.
[b] Preliminary.
[c] Data for Canada include figures for Newfoundland.
Source: United States, Bureau of the Census, U. S. Department of Commerce; Canada and Newfoundland, Newsprint Association of Canada.

Newsprint—United States Imports by Country of Origin

(1000 Short Tons)

Source	*1950*[a]	*1949*	*1948*	*1947*	*1946*	*Source*	*1950*[a]	*1949*	*1948*	*1947*	*1946*
Total[b]	4860	4637	4395	3958	3492	United Kingdom	[d]	35	3	...	...
Canada[c]	4690	4382	4127	3829	3478	Norway	4	30	28	6	...
Finland	144	151	132	84	12	France	2	2	28	10	...
Sweden	18	37	70	25	1	All other countries	2	1	7	4	...

[a] Preliminary.
[b] Data does not necessarily add to total because of rounding.
[c] Includes Newfoundland.
[d] Less than 500 short tons.
Source: Prepared by Pulp, Paper and Board Division, National Production Authority, based upon data from the Bureau of the Census, U. S. Department of Commerce.

Container boards in 1950, at 5.6 million tons, registered an increase of nearly 1 million tons over 1949 and approximately 600,000 tons over the previous high year of 1948.

Wholesale Distribution

The higher level of activity in the industry was likewise reflected at the wholesale merchants level, with sales in 1950 achieving a record high of nearly 1.7 billion dollars compared to the previous high peak year of 1947, when sales totaled 1.6 billion dollars. The higher prices prevalent in 1950 suggest, however, that the actual volume of merchant sales in 1950 may not have been as large as in 1947. It should be recalled, however, that in 1947 there was a substantial movement of paper from the mill level through wholesalers to the shelves of ultimate consumers in an attempt to replace the depleted inventories caused by the advent of World War II. It was not until 1948 and 1949 that it was possible for consumers to regain a stock position consistent with the level of sales. While it is likely that consumers may have desired to have accumulated additional inventories in 1950, it was not possible to do so in view of the increased level of consumption relative to available supplies. Had larger supplies been available in 1950, it is likely that merchants' sales also would have been higher.

Monthly Value of Sales by United States Pulp, Paper, Board and Products Manufacturers, 1946–50 (Unadjusted)

(Millions of Dollars)

Month	*1946*	*1947*	*1948*	*1949*	*1950*	*Month*	*1946*	*1947*	*1948*	*1949*	*1950*
January	337	458	513	462	482	August	386	479	524	463	633
February	316	449	493	444	476	September	364	503	514	503	599
March	351	469	538	479	539	October	427	547	531	518	670
April	360	482	514	445	488	November	424	482	507	503	670
May	375	494	497	428	533	December	426	496	479	460	649
June	362	474	505	429	547						
July	341	431	451	372	489	Total	4467	5763	6066	5511	6776[a]

[a] Preliminary.
Source: Office of Business Economics. The estimated dollar total of sales represents receipts of all operators of paper manufacturing companies. The figures include data for both corporate and noncorporate businesses, but are comparable to the sales data for corporations in *Statistics of Income* published by the Bureau of Internal Revenue.

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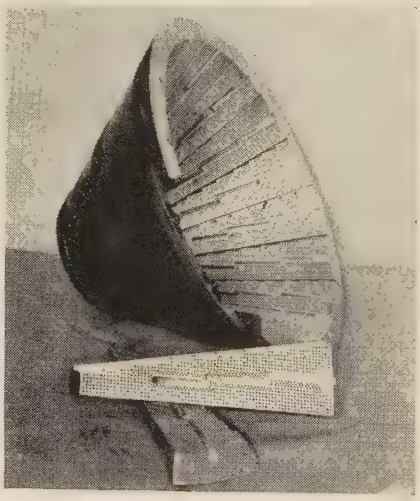

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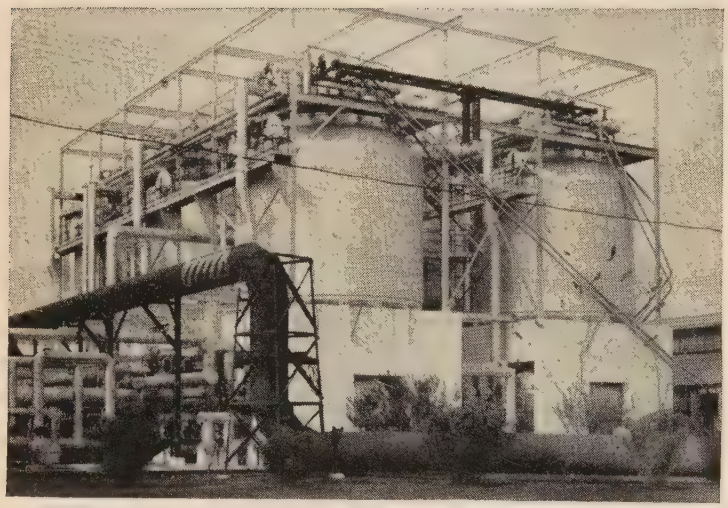

Mining operations are most successfully carried out if the water pumped into the sulphur deposit is heated under pressure to a temperature of about 320° F. For large scale mining, enormous quantities of water are required, so, a primary requisite is an adequate supply of suitable water and an efficient power plant in which to heat it.

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Commercial Sulphite Production Experience with Ammonia-Base Acid

L. A. LaFOND and W. F. HOLZER

Ammonia-base sulphite acid has successfully replaced dolomite-base acid for the cooking of western woods at the Lebanon, Ore., mill of the Crown Zellerbach Corp. The conversion required very little change in equipment and has resulted in greater pulp production capacity, milder cooking conditions, better quality pulp except for color, reduced screenings, better pulp yield, generally improved operating conditions, and savings in operating chemicals and maintenance. Against these advantages has been the cost of ammonia, and an increased slime growth. The first is more than offset by direct savings, the second has been controlled by use of organic mercurial slimicides. The benefits from the use of ammonia are attributed to its ease of handling, its solubility, and its rapid penetration of wood as the base of the cooking acid. No evidence is available as to any difference in its reaction with lignin.

Ammonia has been used as the base in sulphite cooking acid both commercially and experimentally for many years. The process essentially as we know it today was patented by Cross and Engelstad (*1*) in England in 1923, in Germany and France in 1924, and in the United States in 1925. Working under these patents the Norsk Hydro-Elecktrisk Co. made the first commercial application of the process at Toten, Norway, in 1935, and has used ammonia base in this mill ever since (*2, 3*).

Aside from the application in this one mill, the ammonia-base sulphite process remained in the laboratory for many years because of the high cost and fairly short supply of ammonia. In these years many investigations were carried on and, in particular, it was recognized that ammonia-base sulphite acid would pulp species such as jack pine (*4*) and Douglas-fir (*5, 6*) which do not cook satisfactorily with calcium-base acid.

Because of increased manufacturing capacity, installed during the Second World War, ammonia became available at the end of the war in such quantity and price that its use became feasible in pulp manufacture. Two companies, Rayonier, Inc., at its Shelton, Wash., mill and Eastern Corp. at both its mills in Maine, have converted to the use of ammonia base in the past 5 years. At the same time the intensification of the stream improvement program with disposal and utilization of sulphite waste liquor as an important goal, has made the application of soluble bases more urgent. The development of the Weyerhaeuser Timber Co. in the use of MgO base in its Longview mill is well known. In order to acquire detailed information on another soluble base, the Crown Zellerbach Corp. and the Soundview Pulp Co., in a cooperative venture, converted the Lebanon, Ore., mill of the former company to ammonia base in December, 1949. These companies are now starting a pilot plant at Lebanon to study evaporation and burning of the liquor. This paper summarizes the experience on the pulping and bleaching of western woods with ammonia-base acid and on the manufacture of paper from these pulps.

L. A. LaFond, Sulphite Superintendent, Lebanon Div., and W. F. Holzer, Member TAPPI; Assistant Director of Research, Crown Zellerbach Corp., Camas, Wash.

THE LEBANON MILL

The Lebanon mill is located on the south fork of the Santiam River in the Willamette valley about 85 miles south of Portland. The mill produces 55 tons of unbleached sulphite papers daily from western hemlock (*Tsuga heterophylla*) and white fir (*Abies grandis*).

The acid plant is a conventional Barker system formerly using dolomite lime as a base. It has a single rotary sulphur burner followed by a brick-lined combustion chamber and vertical lead coolers. There is a bubble-type liquid level controller in the sulphur burner which keeps the pond level within 0.25 inch. This contributes materially to uniform operation of the sulphur burner.

The gas is absorbed in a four-plate Barker tower, 4.5 feet O.D. Plates are stainless steel with $^3/_8$-inch holes. The Barker tower is followed by a wood stave absorption tower 4 feet I.D., filled to a height of 17 feet with 6-inch spiral tile. Gas is pulled through the system by a stainless steel Nash Hytor pump.

Digester relief gas is cooled in Esco tubular heat exchangers, the cooled gas is absorbed in the acid mixing tank, and overgas from the mixing and storage tanks is absorbed in raw acid in a 4-foot I.D. wood stave tower filled with 8 feet of 6-inch spiral tile. Overgas from this tower is mixed with the burner gas after the cooler.

There are two digesters in use, 15 feet by 40 feet, with a volume of approximately 4300 cubic feet each. The digesters are equipped with external indirect heaters and forced circulation. Strainers in one digester are located just below the dome and circulation is from top to bottom. At present the strainers in the second digester are being lowered to a position just above the cone, and circulation will be from this point to a split return to both top and bottom with probably 75% to the top. A third digester, 14 feet by 40 feet, without forced circulation is available, but is used only when extra pulp is needed.

Pulp is blown into and washed in circular, wood stave blow pits with stainless steel drainer bottoms. Pulp is screened on flat screens consisting of ten sections with twelve plates each, all in a single line.

All screened pulp is passed through a single Morden Stockmaker to storage before going through the beater and jordan system. Screenings are reduced in a Hesse-Ersted refiner and screened over a flat screen with

0.040-inch cut plates. Accepted stock is thickened and collected in a pit for periodic runs of mill wrap, and rejects are recirculated through the refiner.

Paper machines are two fourdriniers, one 74-inch wire and one 86-inch wire. Paper grades are unbleached sulphite wrappings. The refined screenings are used for mill wrap.

CONVERSION TO AMMONIA BASE

Handling of Ammonia

Ammonia is received in the anhydrous form in tank cars. Equipment for converting it to aqua ammonia and tanks for storage are installed according to recommendation of Shell Chemical Co. This is a simple and satisfactory operation. Ammonia is run from the tank car under car pressure and mixed with water in a pipe fitted with baffles. The operation is controlled by the temperature rise of the solution which is directly proportional to its concentration. A temperature controller, with a thermometer bulb in the solution leaving the mixer, is set for the desired temperature rise. The controller actuates a throttling valve on the water supply. A second throttling valve maintains constant back pressure on the solution to insure good mixing. Tanks large enough to hold a car of ammonia at 17% concentration are installed. Emptying a 50,000-pound tank car takes about 8 hours.

Addition of Ammonia to the System

The aqua ammonia is pumped from the storage tanks to the Barker tower by a 5 g.p.m. gear pump with a Vickers hydraulic variable speed drive. The flow is checked and recorded by a recording type rotameter. A flow of approximately 2 g.p.m. is used. This method of metering has proved entirely satisfactory.

The milk of lime flow to the tower formerly was run onto the top plate in normal fashion. It was felt that if ammonia were added here, the inert gases passing through at high vacuum would have a strong stripping action. To prevent this the aqua ammonia is run onto the second plate with the fresh water on the top plate acting as a water seal. No loss of ammonia has been detected.

Instrumentation

The various instruments in use have been mentioned in the discussion except that there are recorders on the water flow to the tower and the vacuum after the coolers and after the tower. Also in use are temperature and SO_2 recorders on the sulphur burning system. During the past year it has been the experience that the acid plant operation with the above instruments and liquid level controller in the sulphur burner was almost automatic. The acid maker makes periodic rounds to check operation but seldom makes an adjustment, adds sulphur to the system, makes hourly tests for the operation report, and acts as digester helper. Figure 1 shows typical charts from a day's operation. Figure 2 includes charts from the SO_2 recorder and the combustion chamber temperature from a day's operation on hand control when the liquid level controller was not working.

Stainless Steel

The Lebanon mill has had a program of replacing old acidproof bronze valves, fittings, etc., with stainless steel as the old parts wore out. Because of the known action of ammonia and its salts on copper, all of the remaining bronze parts in the acid plant and digester room were replaced before the use of ammonia was started. The largest item was replacement of a bronze vacuum pump.

Digester Linings

The digester linings were of standard acidproof brick construction with litharge-glycerine joints and cement grout backing. One lining was almost worn out, the

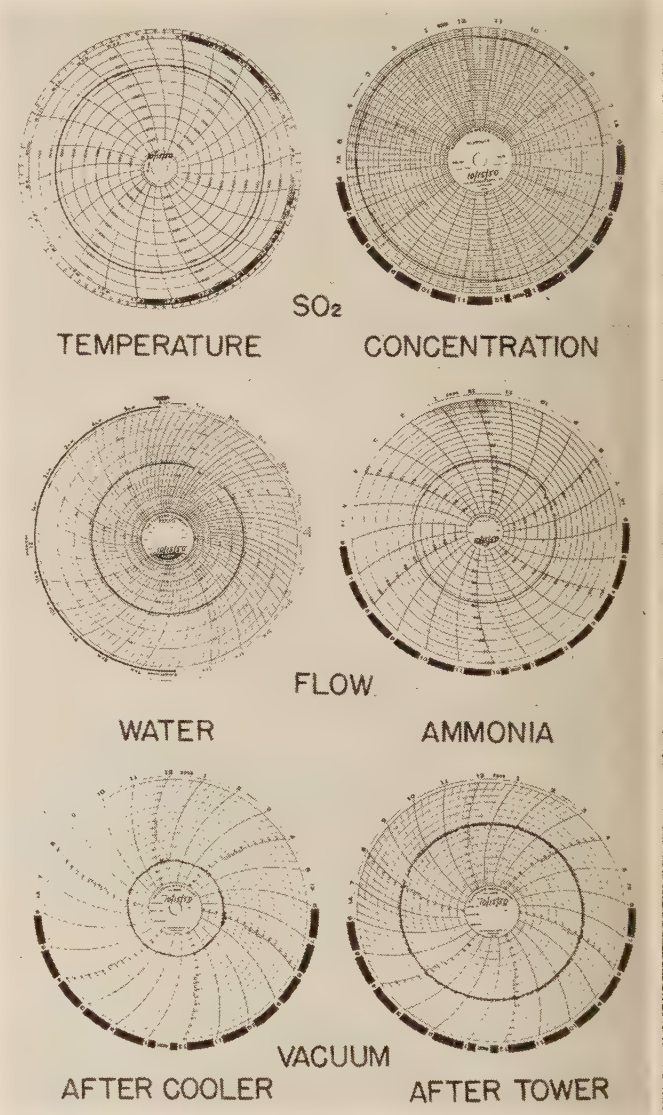

Fig. 1. Recorder charts showing operation of acid plant

second less than a year old. It was decided to do nothing about these linings until necessary. The old lining was replaced last summer with one designed for soluble base consisting of a cement grout next to the shell, a backing of 2-inch acidproof brick laid with litharge-glycerine cement, a facing of 3-inch acid proof brick laid in resin base cement, and resin cement membrane between the two shells of acidproof brick. Such a lining was described by Tucker (7). It is too early to comment on the behavior of this lining, but indications to date are satisfactory. The old type lining is expected to give about half the normal life.

Beyond these points no further preparation was found necessary for conversion from dolomite to ammonia base except to clean the scale from the tower, and the accumulated sludge from the tower sump and the acid tanks.

OPERATING EXPERIENCE WITH AMMONIA-BASE ACID

The Start-Up

In order to cause the least possible disturbance to the system and to pulp quality, it was decided to make the change from dolomite base to ammonia base with no change in combined SO_2 until the effects could be observed, and then as a matter of economy to reduce the combined SO_2 to the lowest possible level over a period of about 6 weeks. Laboratory cooks had indicated a probable lower limit of 0.85%. This program was followed. With the system cleaned of scale and sludge prior to the change, the dolomite disappeared from the acid in less than 2 days.

From experience with calcium base in other mills and from the laboratory, leaks throughout the system and dirt in the pulp were anticipated as the scale was dissolved. It was a pleasant surprise to find that except in the Barker tower there was apparently no scale in the system from the dolomite base, and neither of these difficulties materialized.

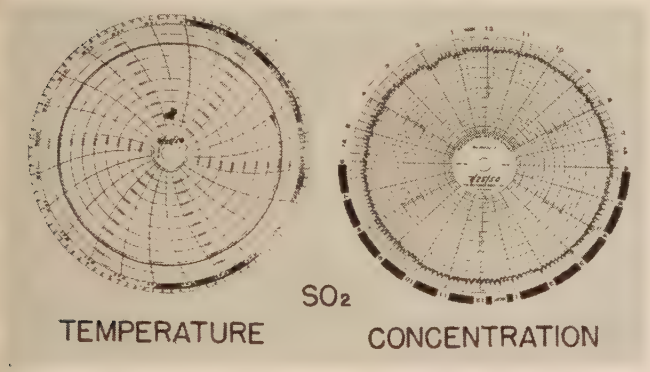

Fig. 2. Recorder charts showing fluctuation of SO_2 concentration and temperature with hand operation of sulphur burner

Acid Plant

The degree of automatic operation in the acid plant has been mentioned. While it is not specifically a part of the ammonia-base installation, the liquid level controller on the pond in the sulphur burner has afforded a degree of control that permits setting the gas at 18 to 19% SO_2 and holding the concentration within 0.5%.

The ammonia supply and general operation of the acid plant are stable enough that the combined SO_2 in the cooking acid seldom varies as much as 0.02% unless changed purposely.

Replacement of dolomite with ammonia has eliminated clean-up of the Barker and the absorption tower. Formerly, 4 to 6 man-hours were spent on these two towers at each weekly shutdown. During the week the acid maker usually had to make a quick clean-out of the Barker tower. In addition to scale and sludge within the system the dolomite lime operation covered the entire acid plant with dust. This, too, has been eliminated and has improved working conditions and appearance.

Digester Operation

The ease of operation found in the acid plant extends to the digesters. Figure 3 shows a typical cooking curve using ammonia-base acid as compared to dolomite base. In some cooks the rate of temperature rise was increased. The only limit found thus far has been the steam supply to the digester. This was confirmed in the laboratory by raising an experimental digester to 248° F. (120°C.) in 50 minutes and to full temperature of 275°F. (135°C.) in 1 hour with only a normal amount of screenings, and a good pulp quality. It is obvious that penetration of the base is rapid.

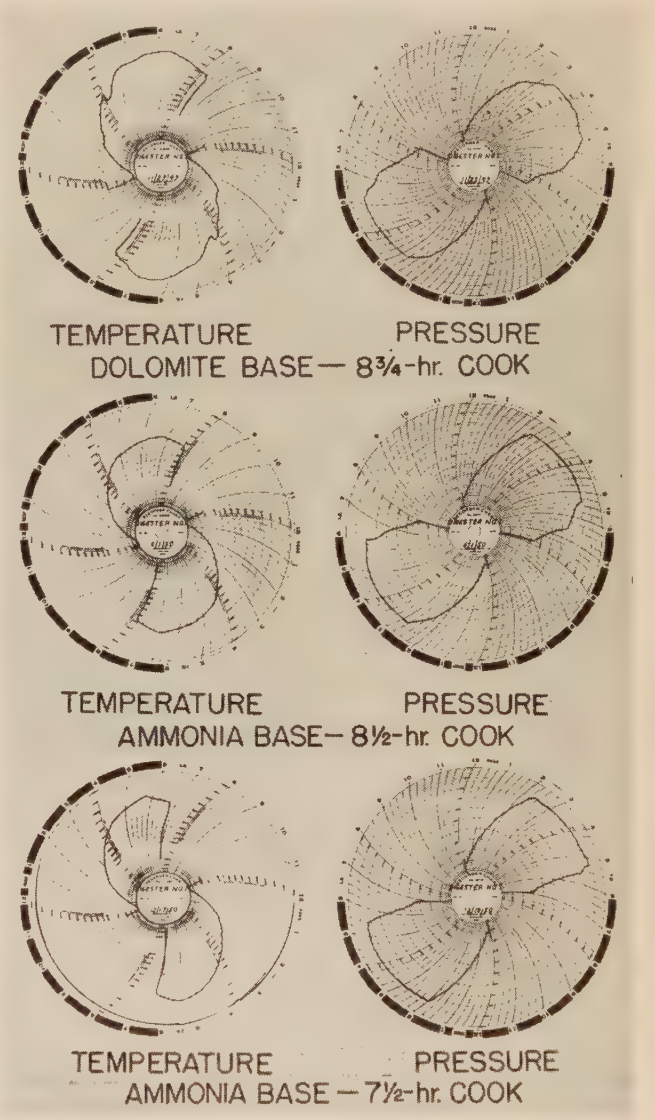

Fig. 3. Digester charts comparing cooking curve of dolomite-base acid to two curves with ammonia base

At the same acid composition the rate of cooking with ammonia base is slightly more rapid than with dolomite. However, with ammonia base the combined SO_2 can be lowered drastically without deteriorating the quality of the pulp, and at lower combined SO_2 the cooking is much more rapid. This can be seen on the cooking

curves from the fact that the cooking temperature was reduced from 286 to 266°F. without changing the time of cooking.

When using dolomite it was necessary to make one or two cooks a week in the spare digester in order to balance the paper machine consumption. Since converting to ammonia base, the two digesters have supplied the full demand of the paper machines while cooking to a maximum temperature of some 20°F. lower. Recently, because of pulp demand, the production of the Lebanon mill has been increased enough to ship about 40 tons a week to other mills. This is still handled by two digesters on a 7.5-hour schedule, and at a maximum temperature 10°F. below that formerly required for dolomite-base acid.

Table I. Strength Comparison of Dolomite and Ammonia-Base Sulphite Pulps Grouped by Combined SO_2

	Dolomite base	*Ammonia base*		
Range of combined SO_2	1.28–1.46	1.30–1.45	1.10–1.19	0.86–1.10
Averages				
Combined SO_2	1.36	1.25	1.15	0.95
TAPPI permanganate no.	18.6	14.6	14.9	16.5
Brightness, G.E.	57.5	55.6	55.8	52.4
Burst				
600 ml.	123	126	128	134
400 ml.	134	136	138	144
Tear				
600 ml.	1.12	1.19	1.19	1.13
400 ml.	0.99	1.07	1.05	1.01
Tensile				
600 ml.	10,140	10,300	10,320	10,730
400 ml.	10,950	11,050	11,240	11,580
Fold				
600 ml.	490	750	720	750
400 ml.	540	830	820	860
Beating time				
To 600 ml.	8.9	6.6	6.8	6.5
To 400 ml.	15.9	12.4	12.8	12.0
Fiber fractionation				
Held on 14-mesh	66.1	68.3	69.5	70.0
Held on 20-mesh	9.1	7.7	7.5	7.2
Held on 35-mesh	7.4	6.5	6.2	5.7
Held on 150-mesh	5.2	5.7	5.1	5.2
Through 150-mesh	12.2	11.8	11.4	11.9

Freeness figures are Canadian Standard.

One change with ammonia base noticed immediately by the cooks was that liquor was considerably darker for a given degree of cooking. Since liquor color is one of the guides for blowing the digester, a new set of color standards had to be prepared. The cooks report that the color of the ammonia base acid is a more reliable indication of degree of cook than that by the dolomite base.

As a general observation it can be said that with ammonia-base acid the cooking procedure is much more flexible and the pulp less subject to damage from improper treatment.

Screening

Because of the paper grades manufactured, the Lebanon mill produces a very hard pulp, to the order of TAPPI permanganate number of 18. A pulp of this nature has very high screenings and is hard to screen. Under normal production it took 4 hours to screen a cook, a capacity of six cooks a day. Since production averaged about 5.5 cooks a day the screens were running very nearly at capacity.

The better penetration of ammonia-base liquor assures a more uniform and more thorough cook. Screenings are decreased by more than half, and small fiber bundles have virtually disappeared. The result has been that a cook is now screened in 3 hours, and the screen tender has far less washing to do. This faster screening is accomplished in spite of the fact that the screen plates have been changed from five sections of 10-cut, four of 8-cut, and one of 6-cut to three sections of 10-cut, four of 8-cut, and three of 6-cut.

The reduction in size of the slots was desirable to screen out the dirt from the ingrown bark around knots that was liberated by the better penetration of the ammonia-base acid.

Beating and Refining

As described under the mill system, all stock is given a prerefining in a Morden Stock Maker ahead of the beaters and jordans. On dolomite-base stock it was the practice to do all the refining possible in the Morden, and finish in the jordan. Some grades, such as butchers' wraps, required full treatment. With ammonia-base pulp, beater and jordan operation is unchanged. The Morden, however, is being used very lightly.

Paper Machine Operation

So far as paper machine operation is concerned there was little change in any section of the machine. Some operators thought the stock handled a little more smoothly on the wire, others did not. Some days it was felt the paper dried a little more slowly. After a year's operation it is generally agreed that if there is any change in the stock behavior on the machine it is very slight.

Bleaching

The Lebanon mill has no bleaching facilities. Commercial bleach trials were run by the Soundview Pulp Co. and in the West Linn Mill of Crown Zellerbach Corp.

At Lebanon there is no opportunity to segregate a single cook, therefore, in order to prepare a softer pulp for bleaching it was necessary to put the entire mill on the soft grade and bleed off a few tons a day until a sufficient quantity was accumulated. On dolomite base, when the permanganate number was reduced to 14 or below, trouble was encountered with both burst and size test of the paper. In this trial, pulp with an average permanganate of 10 was produced during two periods of 2 weeks each without loss of sufficient test to lower the quality of the paper.

At the Soundview Pulp Co. the pulp was run through their normal three-stage process consisting of chlorination, high-density hypochlorite, and low-density hypochlorite. Without taking the time to detail the process it was found that the ammonia-base stock handled as well as or better than calcium-base stock, chlorine usage was equivalent on the basis of bleachability, and buffering caustic was reduced about 30%. Pulp characteristics were equal to or better than the normal calcium-base pulps.

This pulp was sent to a number of customers making diverse grades of paper, and all reports indicated that it performed in normal fashion.

The bleaching trial at West Linn gave substantially the same results. In a two-stage system, chlorination and high-density hypochlorite, operation was normal, and chlorine and buffering alkali usage were very slightly below normal on the basis of bleachability. The pulp was run into coated magazine paper with the result that operation and test were the same as for good calcium-base pulp.

These results are in excellent agreement with our earlier laboratory data which revealed that ammonia and calcium-base pulps bleached in almost identical fashion.

RESULTS OF OPERATION, AMMONIA BASE VS. DOLOMITE BASE

Thus far, we have given a running description of the operation with ammonia base as compared to dolomite with comments on the differences. The results of changes in production can be summarized very readily. The following, referred to dolomite base as standard, have developed over a period of nearly a year since operation on ammonia base has settled into a final pattern:

Screened pulp yield from wood	increased 6%
Screenings yield	decreased 60%
Sulphur consumption	decreased 40 lb. per ton
Ammonia consumption is	85 lb. per ton
Dolomite consumption was	200 lb. per ton
Steam consumption	decreased 200 lb. per ton
Cooking cycle	decreased 12%

In a small mill having a fairly uniform wood supply, making a single grade of pulp, and converting all its pulp to paper, fairly accurate measurements of yield from wood can be made. This increase has been consistent for several months. We attribute it to two things, namely, the reduction in screenings which can account for less than half of the total, and to reduced temperature of cooking.

The most immediate and striking result of the ammonia base was the reduction in both knots and tailings. The refined screenings are collected in a pit for runs of millwrap, formerly at 1-week intervals. Now the screenings must be accumulated for 2 weeks before there are enough. When the first mill wrap run with ammonia base screenings was made it was found that they had been screened so cleanly that it was necessary to add screened pulp in order to carry the sheet over the paper machine. This is a reflection of the elimination of soft fiber bundles by the more thorough penetration of ammonia-base liquor. It has been found desirable to allow some stock to accompany the tailings by flooding the end of the screens. This has produced a cleaner stock as well.

The decrease in sulphur consumption is attributed to the reduction of combined SO_2 from the range of 1.30 to 0.85%. This has been done with no sacrifice in pulp properties except unbleached color.

The low usage of ammonia is a direct reflection of the low combined SO_2. By reducing the ammonia to this level the other direct savings have more than paid the difference in cost between it and the dolomite lime.

The reduction in steam consumption is made possible by the lower maximum cooking temperature.

Table II. Strength Comparison of Dolomite and Ammonia-Base Sulphite Pulps Grouped by TAPPI Permanganate Number

	Dolomite base	*Ammonia base*	*Dolomite base*	*Ammonia base*	*Ammonia base*
Range of permanganate no.	18+	18+	15–18	15–18	15—
Averages					
Combined SO_2	1.34	1.02	1.39	1.16	0.94
TAPPI permanganate no.	19.8	19.9	16.5	15.9	12.8
Brightness, G.E.	56.4	51.7	59.6	54.6	54.6
Burst					
600 ml.	124	136	122	132	128
400 ml.	134	145	133	142	140
Tear					
600 ml.	1.10	1.15	1.14	1.17	1.14
400 ml.	0.98	1.03	1.00	1.05	1.01
Tensile					
600 ml.	10,160	10,620	10,100	10,610	10,620
400 ml.	10,980	11,530	10,900	11,530	11,470
Fold					
600 ml.	470	710	520	710	750
400 ml.	520	820	590	850	830
Beating time					
To 600 ml.	8.8	5.6	9.0	6.1	7.5
To 400 ml.	15.6	10.8	16.1	11.7	13.5
Fiber fractionation					
Held on 14-mesh	65.9	71.2	66.4	69.6	69.1
Held on 20-mesh	9.3	7.1	8.8	7.6	7.2
Held on 35-mesh	7.6	5.7	7.1	6.2	5.9
Held on 150-mesh	5.3	4.9	5.1	5.2	5.7
Through 150-mesh	11.9	11.1	12.6	11.4	12.1

When the change was made from dolomite to ammonia base, there was no need for additional pulp tonnage, and the cooking cycle was held the same by reducing temperature. Recently the mill was speeded up and the cooking time decreased from 8.5 to 7.5 hours, still with maximum temperature below that used with dolomite for an $8^3/_4$-hour cook.

Physical and Chemical Tests of Pulps

Pulp samples were taken periodically the last month of operation on dolomite base and during the first 3 months of operation with ammonia base. During this period it happened that the wood used was almost exclusively western hemlock. The testing period was interrupted by the mill's desire to use up its inventory of dolomite lime before air slaking was serious.

Pulp samples were tested in a laboratory beater according to TAPPI Standard Methods at the Central Research Department of Crown Zellerbach Corp., and were analyzed chemically for some of the more frequently used constants in the laboratory of Soundview Pulp Co.

The data for forty samples are summarized in Tables I, II, and III. Table I presents physical constants of the pulps when grouped by combined SO_2 in the cooking acid. Table II presents these same data regrouped by bleachability of the pulp samples. Table III presents the chemical data when grouped by combined SO_2 of the cooking acid.

Pulp Color

Pulp from western hemlock when cooked by ammonia base is redder than when cooked by dolomite base. At the same combined SO_2 there is a loss of 2 points G.E. brightness or more. As combined SO_2 is decreased the brightness decreases until a drop of 5 to 7 points is suffered with the lowest combined SO_2 used in this operation, that is, 0.85%. This darker pulp

Table III. Comparison of Chemical Characteristics of Dolomite and Ammonia-Base Sulphite Pulps Grouped by Combined SO_2

	Dolomite base	*Ammonia base*		
Range of combined SO_2	1.28–1.46	1.20–1.45	1.10–1.19	0.86–1.10
Averages				
Combined SO_2	1.36	1.25	1.15	0.93
Viscosity, cp.	1087	1632	1928	2215
Alpha - cellulose,[a] %	88.4	88.6	88.3	88.5
Pentosans, %	4.36	4.51	4.18	4.44
Ash, %	0.63	0.31	0.34	0.32
Ether extract, %	0.42	0.41	0.40	...

[a] Uncorrected for lignin.

bleaches to a given whiteness with the same chlorine as is required by a dolomite-base pulp of equal bleach demand.

In Table II it will be noted that pulp color is darker with higher permanganate numbers. This is typical of all pulps, but seems accentuated by ammonia-base acid.

It has been reported to us that when eastern woods are cooked with ammonia-base acid they suffer no brightness loss.

Physical Strength

Ammonia-base pulp has proved consistently superior to dolomite-base pulps in physical strength. This seems to be most striking in fold with a difference of about 50%. Burst and tensile show an advantage of 6 to 7%.

Strength retention at lower bleachabilities in the range of this experience has been excellent for ammonia-base pulps, much better than the mill's previous experience with its standard dolomite pulps. It is also interesting to note the better strength, especially burst, of the lowest combined SO_2 group in Table I. This can probably be attributed to the faster cooking with lower combined SO_2, and therefore, milder conditions.

The rate of beating for ammonia-base pulps is consistently faster than that of dolomite base pulps.

Fiber fractionations show no significant trend.

Chemical Characteristics

The viscosity of ammonia-base pulps is significantly higher than that of dolomite-base pulps. There is also a definite upward trend of viscosity with decreasing combined SO_2. This parallels the case of better test with lower combined SO_2, and the same remarks apply. These viscosity figures testify to the milder action of ammonia-base acid, or possibly the faster action which permits milder conditions.

There are no trends in alpha-cellulose, pentosans, or ether extractives. Ash for ammonia-base pulps was about half that of dolomite-base pulps as might be expected.

Properties of Papers Made from Ammonia-Base Pulps

In the past year the paper quality has generally improved and has been more uniform. The bursting strength has increased in all grades, about 5% in hard-sized and 8 to 10% in average-sized sheets. The tearing strength has remained the same in spite of this increase in burst.

The improvement in size test, both sugar-dye and ink flotation, has been marked. With dolomite-base pulps the ink flotation would deteriorate to some extent over a period of 5 days after manufacture. This seldom occurs with ammonia-base pulps, in fact the test more often improves with time.

In prior operation low test, both physical and sizing, was invariably encountered when permanganate number dropped below about 14. It has been mentioned that a total of 4 weeks' operation at permanganate number of 10 was carried on and with no decrease of test below the former level of dolomite pulps. As a matter of safety when the soft pulp runs started, less critical grades were scheduled, but after the first few days, no further selection of orders was made.

Further evidence of improved quality was found in the white fir usage. With dolomite-base acid 30% was considered maximum usage for this species because of lower strength. For the month of Sept., 1950, the white fir usage averaged 50% with no observed effect.

GENERAL COMMENTS

Slime Growth

One condition not anticipated, but readily understood when encountered, was a vigorous growth of slime in the pulp system from the knotter through the deckers. In this area there are still appreciable amounts of waste liquor in the stock, and the nitrogen present is an excellent nutrient for microorganisms.

A second experience with slime was encountered in a lapped stock pile set aside for emergencies. This was covered to exclude dirt, and when examined after several weeks was found to be riddled with slime growth.

Both of these conditions were brought under control by use of organomercurial slimicides. In the pulp mill the screen boxes are sprayed weekly with concentrated chemical, and the system is given a shock dose every day. On the lapped stock problem a new pile was started and the outside surfaces were sprayed with diluted chemical. Results have been excellent in both instances.

Action of Ammonia-Base Acid

The reason for the improved pulping action with ammonia-base acid has been the subject of considerable speculation. There is ample evidence that a very much more rapid and thorough penetration of the base is responsible for a large share of the change. Whether or not there is a different reaction with the lignin is not known, but this is the subject of a laboratory program.

The evidences of faster penetration have been mentioned and need only be summarized. They are the ability to steam a digester faster with no increase in screenings, the marked reduction in screenings in general, and the reduction in shives which permits much more rapid screening.

An item not previously mentioned was an experiment by the mill in which the chip screens were shut down. There was no increase in knots except for a very small amount of slivers over 3 inches long.

Operators' Reaction

Supervisors are well acquainted with the average operator's resistance to something new. In the case of ammonia base the change-over was so smooth, results were so immediate, and operation was made so notice-

ably easier that the operators are unanimous in their praise of the new system.

General

Ammonia-base acid at the Lebanon mill has increased the pulp mill capacity, improved pulp yield, improved operation, improved pulp strength, and decreased maintenance. Against these are the increased chemical cost, an increased slime trouble, and a darker color of unbleached pulp. The first is offset by direct savings in operation, the second is readily controlled, and the third has not proved a disadvantage in the grades manufactured. We are confident that other mills could obtain similar results. Whether they would prove advantageous would necessarily be judged by each mill separately.

It is well known that this work on ammonia base was prompted by the need for a soluble base in sulphite waste liquor so that the liquor could be evaporated in preparation for burning or other utilization. The application of ammonia to the cooking process and the use of these pulps in papermaking constitute only the first phase in the over-all problem of stream improvement. While the possibility of using ammonia was being proved, the second phase, the evaporation and burning of the liquor, has been in preparation. A pilot plant to evaporate and burn 20% of the mill's waste liquor has been designed and installed, and is now starting operation.

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Agricultural Residue Pulps—Crotalaria Pulps

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Crotalaria is one of the more important leguminous crops grown on the sandy soils of southeastern United States for erosion control. The two most common varieties, *Crotalaria mucronata* and *Crotalaria spectabilis*, produce high yields of seed and up to 10 tons of green or 2 tons of dry forage per acre. A number of pulping trials were made on these stalks, using the neutral sulphite and kraft processes. Crotalaria required more cooking chemicals and generally longer cooking periods than are necessary to pulp wheat straw. Lower yields of pulp were obtained from crotalaria than from wheat straw but the crotalaria pulps were stronger, particularly in tear resistance and folding endurance. In general, the kraft process produced stronger pulp than the neutral sulphite process but the kraft pulp yields were lower. These preliminary experiments indicate that, from a technological standpoint, crotalaria has good possibilities as a raw material for pulp and paper manufacture. Economic considerations, however, will undoubtedly be the controlling factors in the possible utilization of crotalaria for pulp and paper production.

Crotalaria is one of the newer leguminous crops to become important in recent years in the United States for seed, green manure, and erosion control. It is well suited to the sandy soils in the coastal-plains region of the southeastern states. Figures on the actual acreage are not available, but from general information probably 500,000 acres were seeded in 1945 for soil improvement (*1*).

Many species of crotalaria have been tried but the two most commonly used are *Crotalaria mucronata* (commonly called giant striata) and *C. spectabilis*. These two varieties produce high yields of seed and up to 10 tons of green stalks, equivalent to 2 tons of dry forage per acre. In general, the crotalaria plant has not been too well accepted for forage since some species are unpalatable, and others have been found poisonous to livestock.

A satisfactory silage can be made from the young green plants. Plowing under the green growth results in considerable benefit to the soil. As the plant matures it becomes woody and more difficult to cut and turn under with light farm implements, thus necessitating removal of a portion of the stalks from the soil.

Crotalaria makes more growth in light sandy soil than most other legumes. Because it harbors no nematodes and its roots are generally well noduled by nitrogen-producing bacteria, the crop is especially useful in the South where nematodes are abundant and sandy soils predominate. Crotalaria needs a well-drained soil, is not adapted to heavy clay; the plants may reach a height of more than 7 feet and can be harvested either by the binder or combine method. The well-branched stalks produce a considerable amount of seed.

The relatively large yields of crotalaria stalks in the southeastern states and the unsuitability of the plant for forage or feed suggested the possibility of the stalks as papermaking raw material, particularly those of the giant striata variety which are relatively large and woody.

Samples of two species, *C. spectabilis* and *C. mucronata* (giant striata), were submitted to the Northern Laboratory for preliminary pulping trials and for determining the properties of the pulps so produced. This report embodies the results of these preliminary experimental studies. Some available data on wheat straw are included for comparison.

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Table I. Physical Condition and Proximate Chemical Analysis of Crotalaria

Sample no. (N.R.R.L.)	*3503*	*3504*	*3505*	*3506*	*3974*	*3975*	*4082*
Variety	*C. mucronata*	*C. mucronata*	*C. mucronata*	*C. spectabilis*	*C. mucronata*	*C. mucronata*	*Kawvale wheat straw*
Crop year	*1943*	*1943*	*1943*	*1943*	*1944*	*1944*	*1945*
Condition as received	*5–7 foot stalks—with some seed pods*	*Chopped stalks—length, 2–6 inches*	*Decorticated fiber—considerable woody material*	*Decorticated fiber—some woody material*	*4–5 foot stalks*	*Chopped, 2–6 inches—some dirt and moldy material*	*Bright, sound – relatively free from chaff*
Chemical analysis:[a]							
Moisture, %	4.1	6.8	7.2	7.3	8.0	7.8	8.3
Ash, %	1.1	2.4	1.2	2.1	1.3	1.0	6.3
Extractives							
Alcohol-benzene (1:2), %	1.6	2.4	2.7	2.9	2.2	1.5	2.5
Hot water, %	9.0	8.4	7.0	7.6	7.6	5.2	10.0
1% NaOH, %	28.2	29.9	27.2	28.9	27.2	23.7	41.2
Lignin, %	21.3	28.6	23.2	22.8	20.8	21.2	16.8
Pentosans, %	20.0	21.4	19.8	16.7	18.6	18.0	31.9
Cross and Bevan cellulose (ash-free), %	56.1	46.2	59.2	55.5	56.3	56.0	54.7
Pentosans in Cross and Bevan cellulose, %[b]	19.2	23.4	16.8	15.0	20.7	19.5	27.0
Alpha-cellulose, %	40.5	29.9	42.5	41.1	41.2	40.6	37.3
Pentosans in α-cellulose, %[c]	...	2.5	3.0	0.7	3.8	1.4	4.2
Holocellulose, %	67.4	62.6	73.9	65.8	69.2	70.8	69.2

[a] All values, except moisture, on oven-dry basis.
[b] Based on Cross and Bevan cellulose.
[c] Based on alpha-cellulose.

EXPERIMENTAL

A sample of the 1943 crop of *C. spectabilis* and several of the 1943 and 1944 crops of *C. mucronata* (giant striata) stalks were obtained from McBee, Chesterfield County, S. C. The giant striata was received in the form of whole stalks, chopped stalks, and partially decorticated fiber, while only partially decorticated fiber of *C. spectabilis* was obtained. The whole stalks were 4 to 7 feet long and well branched on the upper parts. The diameter at the base of the stalks was $^1/_4$ to $^1/_2$ inch. The decorticated material consisted of the outside bast fiber with a considerable amount of woody material clinging to it.

The crotalaria stalk has an almost circular cross section. The central portion, constituting about $^1/_3$ of the diameter of the stalk, consists entirely of pith. This is surrounded by a layer of woody fibrous material which is, in turn, covered by a thin, relatively tough sheet of fibrous bast tissue.

The condition of the various samples of crotalaria as received at the Laboratory and their proximate chemical analysis are given in Table I. All procedures used for chemical analysis were TAPPI methods, or modifications of those methods previously reported (*2*, *3*). It may be noted from the data that, except for sample 3504 which had a higher lignin and lower cellulose content, the various crotalaria samples were chemically similar. The comparison of crotalaria with wheat straw indicates that while both materials had approximately the same Cross and Bevan cellulose content, the crotalaria had more α-cellulose and less pentosans than the wheat straw. The lignin content of the crotalaria stalks was greater than that found in wheat straw. From chemical analysis it thus appears that crotalaria might be suitable for the manufacture of paper and cellulose products.

Since the available amounts of samples 3503, 3504, and 3974 were sufficient for only one or two laboratory cooks, the pulping data on these samples are not included in this report. The pulping trials on sample 3505, 3506, and 3975 were made on the materials as received with no pretreatment prior to cooking.

The pulping studies on the crotalaria stalks were carried out by the neutral sulphite and kraft processes. The methods of cooking and of screening and testing the pulp were the same as those described previously in connection with the preparation of wheat straw pulp (*2*, *3*). Bleach consumption of the screened pulp, that is, the chlorine required to produce a brightness of 70% (Hunter reflectometer) and the yield of bleached pulp were estimated by the single-stage hypochlorite method, using 10-gram samples (*2*).

At the end of the cooking period the pressure in the digester was lowered to approximately 40 p.s.i. and the charge was "blown" in the usual manner. The digester charges did not always blow cleanly, particularly those in which uncut decorticated crotalaria was used. In screening, these crotalaria pulps behaved much like flax straw pulp in that the long bast fibers matted together, entrapping the cooked woody fiber and some of the shorter bast fibers which normally would go through the 8-cut screen plate. The cooked materials discharged from the digester were defibered, therefore, in a 5-pound Noble and Wood beater in order to cut the fibers to the length that could be screened in the normal manner. Thus, the amounts of screened pulp obtained in this series of cooks were, therefore, not a very good indication of the degree of cooking of the crotalaria.

The cooking conditions, pulp yields, and the chemical characteristics and physical properties of the pulps are given in Tables II and III, and illustrated graphically in Figs. 1 and 2. All chemical analyses and physical tests on the pulps were made in accordance with TAPPI standard methods, and the reported results are the mean of two or more individual runs in good agreement.

RESULTS AND DISCUSSION

Neutral-Sulphite Pulps

Fairly satisfactory pulps were obtained by cooking crotalaria with sodium sulphite and sodium carbonate as shown in Table II. More than twice as much chemical was required for producing pulp from crotalaria as from wheat straw, and crotalaria also generally required longer cooking periods. Except for pulps from chopped *C. mucronata*, the yields of screened crotalaria pulps were lower than those obtained from wheat straw.

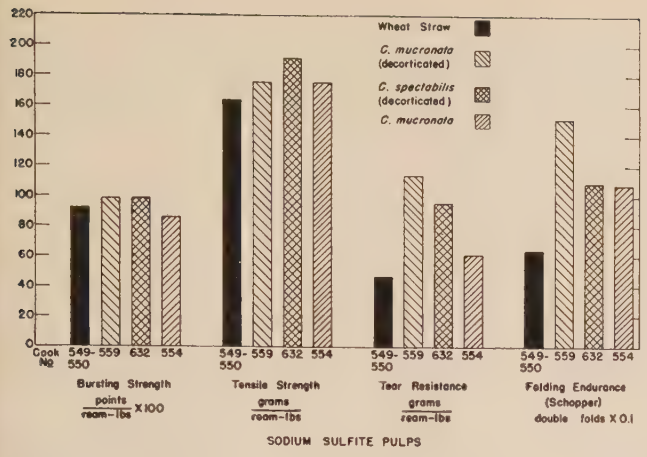

Fig. 1. Comparative strength properties, at maximum bursting strength, of crotalaria and wheat straw neutral sulphite pulps

The yields from chopped *C. mucronata* and from wheat straw were fairly comparable. It must be pointed out again that, because it was necessary to shorten the crotalaria pulp fibers in the laboratory beater before screening, the screened yield figures for the crotalaria pulps may not be the true values. An increase in cooking time from 2 to 4 hours, with all other conditions remaining constant, resulted in a decreased yield of total pulp but a somewhat increased yield of screened pulp, as shown by cooks 632 and 633, Table II. No significant effect on yield was obtained by increasing the amount of chemical from 24 to 35%, based on dry raw materials, as shown in cooks 554, 557, and 566 on chopped *C. mucronata*.

The crotalaria pulps contained less ash and pentosan and more lignin than the wheat straw pulp. The lower ash and pentosan values of the crotalaria pulps may be expected from the analytical values given in Table I. The relatively high lignin contents of the crotalaria pulps, however, indicate incomplete cooking. These larger lignin values are corroborated by the higher permanganate numbers and larger chlorine requirements of the crotalaria pulps. It is very probable that with more chemical, and/or longer cooking periods, the lignin content of the crotalaria pulps would be reduced to the range generally required for easy-bleaching pulps.

The physical strength data on these pulps, as indicated in Table II and illustrated in Fig. 1, show that, in general, the crotalaria pulps are at least equal to the neutral sulphite wheat straw pulp in bursting and tensile strength, and quite superior in tear resistance and folding endurance. The relatively high tear resistance and folding endurance of crotalaria are undoubtedly due to the presence of the longer bast fibers in the pulp. A comparison of the chopped crotalaria (sample 3975) and the decorticated material (sample 3505) shows the superiority of the latter in producing stronger pulps, particularly with regard to tear resistance and folding endurance. Extending the cooking period resulted in somewhat stronger pulp as indicated by cooks 632 and 633, Table II. An increase in the amount of cooking chemical also resulted in somewhat better pulp (cooks 554, 557, 566). As with straw pulp, bleaching the neutral-sulphite crotalaria pulps (cook 557) resulted in a definite increase in strength properties. The chlorine requirement was higher and the yields of bleached pulp lower, however, for crotalaria than for wheat straw pulp.

Kraft Pulps

As in the neutral-sulphite process, more chemical and/or longer cooking periods were required for producing kraft pulps from crotalaria than from wheat straw. With this process, however, the yields of pulp from crotalaria were in the same range as those obtained from wheat straw, as indicated in Table III. It is probable that the screened crotalaria pulp yields obtained with this more drastic pulping method are closer to the true values. The yield of crotalaria kraft pulp showed a definite decrease with increasing cooking chemicals in contrast to the results obtained with the neutral-sulphite process.

The ash and pentosan contents of the crotalaria kraft pulps were lower than those of the wheat straw kraft pulp. The increase in cooking chemicals or in cooking time seemed to have but little effect on either the ash or the pentosan content of the crotalaria pulp. The lignin content decreased generally with increasing chemical concentration and with a longer cooking period. The lower lignin content of the well-cooked crotalaria kraft pulps compared favorably with that of the straw kraft pulp. As expected, the permanganate number and the chlorine requirement of the crotalaria kraft pulp decreased with lignin content.

The strength values of the crotalaria kraft pulp, particularly tear resistance and folding endurance, were fairly high as indicated in Table III and illustrated in Fig. 2. The bursting and tensile strengths of the crotalaria pulps were only slightly better than those of the wheat straw pulps, but the crotalaria pulps had better tear resistance and folding endurance, particularly in the case of the better-cooked pulps. In contrast to the results obtained with wheat straw, the crotalaria pulps showed a tendency to lower tear resistance and lower folding endurance with an increase in cooking chemicals used to produce these pulps. The bursting strength and tensile strength, however, generally increased with the increasing degree of pulping or delignification. The pulp from the decorticated *C. mucronata* was generally stronger in all respects than that obtained from the chopped material.

Bleaching generally enhanced the bursting strength and lowered the tensile strength of the crotalaria pulps, as shown by cooks 586 and 555. The increment increase

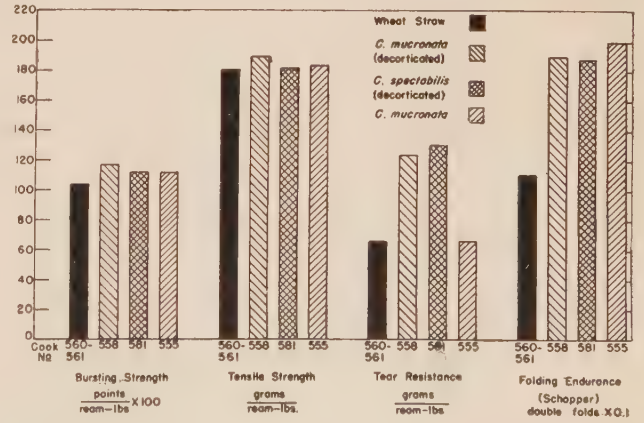

Fig. 2. Comparative strength properties, at maximum bursting strength, of crotalaria and wheat straw kraft pulps

Table II. Pulping Crotalaria: Cooking Conditions, Yields, and Chemical and Physical Properties of Pulps—Neutral Sulphite Pulps

Cook no.	Material	Cooking conditions: Chemicals[a] Na_2SO_3, %	Na_2CO_3, %	Time of cooking, hr.	pH of liquor: Initial	Final	Pulp yields[a]: Crude, %	Screened, %	Screenings, %	Fines, %	Chemical constants[b]: Ash, %	Pentosans, %	Lignin, %	$KMnO_4$, no.	Bleaching: Chlorine consumption, %[b]	Bleached yield, %[a]	Physical constants at maximum bursting strength: Time of beating, min.	Freeness (S.R.), ml.	Basis weight (25 × 40—500), lb.	Bursting strength, points/ream, lb. × 100	Tensile strength, g./ream-lb.	Tear resistance, g./ream-lb. × 100	Folding endurance (Schopper), double folds	Apparent density, g./ml.
549–550	Wheat straw	8.0	3.0	2	10.4	7.1	61.5	55.5	1.3	4.5	7.7	25.7	5.1	16	6.8	53.7	60	430	49	92	163	47	643	0.90
					Bleached						6.7	25.9	2.0	..	6.2	52.1	45	...	48	96	154	60	1149	0.89
559	*C. mucronata*—decorticated (3505)	20.0	4.0	4	10.4	8.4	58.6	49.5	2.4	6.7	1.9	15.5	10.7	28	15.6	41.8	45	330	47	99	176	114	1520	0.84
565	*C. mucronata*—decorticated (3505)	25.0	5.0	4	10.5	8.4	58.2	49.5	2.7	6.0	1.8	16.9	10.6	29	18.8	40.0	60	240	49	102	172	103	1600	0.81
633	*C. spectabilis*—decorticated (3506)	20.0	4.0	2	10.1	8.6	63.3	44.9	7.5	10.9	2.0	15.7	13.4	33	25.3	34.5	60	240	46	77	162	103	825	0.83
632	*C. spectabilis*—decorticated (3506)	20.0	4.0	4	10.1	8.6	58.9	47.3	3.0	8.6	2.3	15.6	10.5	30	16.3	37.0	60	270	45	99	192	96	1090	0.86
634	*C. spectabilis*—decorticated (3506)	30.0	6.0	2	10.3	8.9	61.0	43.8	8.5	8.7	2.7	15.8	12.4	35	21.8	32.7	60	210	49	80	168	66	820	0.83
554	*C. mucronata* (3975)	20.0	4.0	4	10.4	8.8	62.4	52.8	2.9	6.7	1.8	21.3	12.4	34	22.6	45.1	60	320	46	86	176	62	1080	0.95
557	*C. mucronata* (3975)	25.0	5.0	4	10.5	8.5	62.3	55.7	1.8	4.8	1.8	18.7	11.6	33	18.8	48.0	60	270	46	87	166	65	1000	0.86
557	*C. mucronata* (3975)				Bleached						0.9	19.7	1.5	..	13.3	46.9	30	380	46	110	18	75	1020	0.95
566	*C. mucronata* (3975)	30.0	5.0	4	10.5	8.4	62.0	53.9	1.7	6.4	1.8	18.5	11.0	31	18.0	48.7	60	230	51	102	160	71	1080	0.89

[a] Based on oven-dry raw material. [b] Based on oven-dry unbleached pulp.

Table III. Pulping Crotalaria: Cooking Conditions, Yields, and Chemical and Physical Properties of Pulps—Kraft Pulps

Cook no.	Material	Cooking conditions: Chemicals[a] NaOH, %	Na_2S, %	Time of cooking, hr.	pH of liquor: Initial	Final	Pulp yields[a]: Crude, %	Screened, %	Screenings, %	Fines, %	Chemical constants[b]: Ash, %	Pentosans, %	Lignin, %	$KMnO_4$, no.	Bleaching: Chlorine consumption, %[b]	Bleached yield, %[a]	Physical constants at maximum bursting strength: Time of beating, min.	Freeness (S.R.), ml.	Basis weight (25 × 40—500), lb.	Bursting strength, Points/ream, lb. × 100	Tensile strength, g./ream-lb.	Tear resistance, g./ream-lb. × 100	Folding endurance (Schopper), double folds	Apparent density, g./ml.
393	Wheat straw	5.3	2.6	2	...	9.8	57.8	44.4	1.8	11.6	6.7	26.5	9.0	36	21.6	39.8	45	395	46	93	173	43	733	0.91
393	Wheat straw				Bleached						5.0	26.7	2.5	..	18.0	40.2	45	290	46	102	134	44	1170	0.95
560–561	Wheat straw	8.0	4.0	2	...	10.4	53.3	47.1	0.8	5.4	4.7	29.4	3.4	15	5.9	43.7	45	350	46	104	181	66	1107	1.02
564	*C. mucronata* (3505)	10.0	5.0	2	11.2	10.0	56.1	46.9	1.5	7.7	2.4	15.1	13.7	37	27.4	36.0	45	450	47	98	158	124	2400	0.87
558	*C. mucronata* (3505)	13.3	6.7	2	11.4	11.4	47.9	44.0	0.4	3.5	2.9	16.6	4.8	18	7.6	40.8	45	420	47	117	190	124	1900	0.86
586	*C. mucronata* (3505)	16.6	8.4	2	11.4	11.4	47.2	43.1	0.0	4.1	2.5	15.7	5.3	12	6.6	40.8	45	440	42	115	208	95	1740	0.86
586	*C. mucronata* (3505)				Bleached						1.4	16.3	0.3	..	4.6	40.7	45	380	46	122	195	73	1620	0.98
584	*C. spectabilis* (3506)	6.7	3.3	4	11.0	9.3	61.6	51.0	2.8	7.8	2.0	13.1	13.1	62	44.6	41.5	45	320	42	72	148	76	650	0.79
583	*C. spectabilis* (3506)	10.0	5.0	4	11.2	10.5	52.1	47.7	0.1	4.3	2.6	12.9	13.7	43	32.6	40.8	45	370	49	84	156	118	1575	0.79
581	*C. spectabilis* (3506)	13.3	6.7	4	11.4	11.2	47.5	42.3	0.2	5.0	2.2	13.6	5.5	21	11.6	39.5	30	510	34	112	182	131	1880	0.78
555	*C. mucronata* (3975)	13.3	6.7	2	12.4	10.5	50.6	47.2	0.5	2.9	2.4	18.0	4.7	22	9.6	43.5	75	420	46	112	184	67	2000	1.06
555	*C. mucronata* (3975)				Bleached						1.0	18.0	0.2	..	7.0	44.3	60	360	47	113	170	70	2250	1.04
556	*C. mucronata* (3975)	13.3	6.7	4	12.4	11.0	49.4	45.7	0.2	3.5	3.3	18.6	3.3	20	8.9	40.0	75	380	47	107	178	63	1550	1.04
585	*C. mucronata* (3975)	16.6	8.4	2	12.4	11.2	50.2	45.8	0.1	4.3	3.3	17.9	6.0	14	8.6	40.0	60	460	48	94	182	60	1300	0.78

[a] Based on oven-dry raw material. [b] Based on oven-dry unbleached pulp.

in folding endurance on bleaching was greater for the straw pulp than for the crotalaria pulps, probably because of the high folding endurance of the unbleached crotalaria pulps.

GENERAL CONSIDERATIONS

These preliminary results, although meager, show that from the technological viewpoint crotalaria can be considered as a suitable raw material for the pulp and paper industry. The chemical requirements for pulping the crotalaria stalks put it in the same class with hardwood; as a matter of fact, crotalaria is very similar to hardwood on the basis of proximate chemical analysis. The above results indicate, however, that crotalaria can produce stronger pulps than are obtainable from most hardwoods, probably because of the long bast fibers available in the crotalaria stalk. While pith fibers are generally very short and undesirable for papermaking from both technological and economical standpoints, the deleterious effects of the pith on crotalaria pulp strength is apparently more than overcome by the presence of the strong, long bast fibers.

The bars in Figs. 1 and 2, which illustrate the higher strength characteristics of crotalaria pulps compared with the straw pulp, also show that the pulp from decorticated crotalaria was generally better than that from the whole stalk. This was particularly true in regard to tear resistance, a property which is almost directly related to fiber length. The folding endurance which is dependent both on fiber length and on its flexibility (degree of delignification) was also generally higher for the decorticated crotalaria. It is probable that the superiority of decorticated over whole crotalaria could have been shown more conclusively if decortication had been more thorough in separating the bast fiber from the woody material.

Crotalaria stalks are perhaps more nearly comparable to flax straw. The chemical analyses of these two materials are very similar and both contain the three types of fiber, pith, woody, and bast (*4*). Flax tow, the decorticated fiber from seed flax straw, is used extensively in the manufacture of cigarette and other lightweight, strong papers. Information received at the Laboratory on experiments elsewhere showed that decorticated crotalaria may have some promise for the manufacture of such types of paper.

It must be pointed out at this time that the technological suitability of a raw material for papermaking is not the only criterion which must be considered. The economics of producing pulp and paper from crotalaria, including availability, methods and costs of collection, storage, cost of conversion into pulp, etc., is equally, if not more important. This cannot be overemphasized. For example, the strength advantages of crotalaria pulps over those of wheat straw, as reported here, may be more than counterbalanced by the ready availability of straw at reasonably low cost, and by the higher yield of pulp from straw.

Assuming that 500,000 acres are planted to crotalaria, the reported yield of 2 tons of dry fiber per acre places the total annual production at about 1 million tons. Of course, all of the crotalaria will not be available for industrial uses, since the main purpose of the crop is to build up the soil and reduce erosion. Only that portion of the crop which is not turned back to the soil as green manure might be available. A 100-ton per day pulp mill, which is considered a small operation at present, would have an annual crotalaria requirement of 65,000 to 75,000 tons of dry fiber. This amount represents about 7% of the total crotalaria produced in the southeastern states. Methods and costs of collection, storage, and handling would have to be worked out to determine whether such costs would fall within a range low enough to assure the pulp mill of a profitable operation.

A most important consideration regarding crotalaria is its permanence as a raw material for the pulp and paper industry. Since the crop is grown primarily for soil improvement and erosion control, and since it has no particular value as feed or for other farm uses, it is possible that soil, after being improved by crotalaria, will be planted to more profitable crops in rotation. In such a situation the price a farmer would have to request for continued planting of crotalaria would probably be considerably more than pulp producers or other industrial users of crotalaria could afford.

There is the possibility, of course, that the bast fiber of crotalaria could find use in the textile industry along with hemp and flax bast fibers. In that case, only the woody portion of the stalk, containing more or less bast fiber remnants, would be available to the paper industry. If the woody portion of the crotalaria stalk is analogous to flax shives or hemp hurds, it would offer no inducement as a raw material for pulp or paper production.

SUMMARY

1. A number of pulping trials, with the neutral sulphite and kraft processes, were made on crotalaria stalks.

2. Crotalaria required more cooking chemicals and generally longer cooking time than is necessary to produce a pulp from wheat straw. The yields of pulp from crotalaria were somewhat lower than those obtained from wheat straw but the crotalaria pulps were stronger, particularly in tear resistance and folding endurance.

3. The crotalaria kraft pulps were stronger than the crotalaria neutral sulphite pulps but the kraft pulp yields were lower.

4. These preliminary experiments indicate that from a technological standpoint, crotalaria has good possibilities as a raw material for pulp and paper manufacture.

5. Economic considerations will undoubtedly be the controlling factor, however, in the possible utilization of crotalaria for pulp and paper manufacture.

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The Effect of Silicates on Digester Corrosion

J. C. HAIR and A. W. DUSKIN

In an attempt to decrease the corrosion rate in its digesters, Crossett Paper Mills added sodium silicate and high-silica clays to the liquor system with the anticipation that a protective scale would be formed in the digesters, and corrosion thereby inhibited. At the conclusion of a 9-month test, there had been no formation of a high-silica protective scale, nor had there been any reduction in the corrosion rate.

DIGESTER corrosion in southern sulphate pulp mills has in recent years become a problem of vital importance. With the introduction of the use of the "Audigage" by Crossett Paper Mills early in 1949 as a means of measuring digester wall thickness, pulp mills in the south suddenly realized that their digester shells were becoming dangerously thin and as a result, many mills began replacing this equipment. After reading C. Benedicks' (*2*) original paper on digester scale, D. B. Kuhe, Assistant Division Manager, Crossett Paper Mills, and K. G. Chesley, Research Director, Crossett Lumber Co., suggested a plant scale project of using silicates to form a protective scale in sulphate digesters.

The purpose of this paper is to present the corrosion problem at Crossett Paper Mills and to outline the methods used in attempting to arrest digester shell deterioration. Although the results of this study are negative, it is felt that the material contained in this report will be of vital interest to the sulphate pulping industry and will further aid in solving this problem.

Had we at Crossett had access to a paper showing the results of adding sodium silicate to digesters, it would no doubt have saved us several months of work and considerable cost. Therefore, we feel that although our results are negative, our work will benefit the industry by getting in the literature the results of adding sodium silicate to digesters under the condition set forth herein.

There is very little published material on the utilization of silica as a means to combat corrosion in sulphate digesters. Several authors, writing about digester corrosion, hint at a possible connection between the corrosion rate and the presence of silicon compounds, but nothing very specific so as to be useful. The earliest record of the use of silica to decrease digester corrosion that the authors found was at West Virginia Pulp and Paper Co. (*1*). In the early 1920's West Virginia attempted to protect their digesters by putting in baffle plates and adding calcium chloride and sodium silicate. It was thought that this combination would cause the formation of a protective scale. No record of the results was available, but apparently it was not successful since the practice was discontinued.

In an article (*2*) appearing in *Svensk Paperstidn.*, C. Benedicks writes of the finding of a protective coating in a stationary kraft digester which he was investigating in a Swedish mill. An analysis of the protective scale showed it to consist largely of calcium carbonate with a high silicon dioxide content of approximately 9.7% together with considerable iron and aluminum oxide and an undetermined content said to consist mostly of alkali. In the same mill, Benedicks found another scale which afforded very little protection against corrosion. An analysis of this scale demonstrated this material to be practically all calcium carbonate with a silicon dioxide content of approximately 0.7%. Microscopic examination of this scale showed a single crystallized substance, which Benedicks writes was obviously calcium carbonate.

A miscroscopic examination of the protective coating or scale revealed it to be microscopically heterogenous. It was also discovered that the protective coating was more durable and not so brittle as the nonprotective coating.

Von Essen (*3*) ran experiments using sodium silicate as an inhibitor which resulted in a reduced corrosion rate, however, he did not give the concentration of sodium silicate used, nor the method of addition. It was Von Essen's opinion that it is possible to obtain protection of existing plate material against corrosion on the liquor side by means of galvanic currents, or by connection to a current source which possibly causes the silicic acid in the liquor to be deposited on the anode and thus protect it against further attack.

THE CORROSION PROBLEM

The seriousness of the digester corrosion problem at Crossett is easily recognized if we look at Table I.

Table I. Digester Penetration Rate
(July, 1945–March 1, 1949)

Digester No.	Age		Thickness,[a] in.		Penetration	
	1000 Cooks	Years	Thinnest spot	Sectional average[b]	In./Yr.	In./1000 cooks
1	9.11	3.89	0.43	0.97	0.104	0.044
2	8.85	3.64	0.77	1.02	0.097	0.040
3	8.76	3.61	0.83	1.05	0.090	0.037
4	8.67	3.58	0.74	1.05	0.091	0.037
5	9.02	3.79	0.41	0.92	0.120	0.050

[a] Original thickness—1.375 in.
[b] Cylindrical section 9 feet high in middle of digester wall.

This table shows the rapid corrosion that has taken place in five digesters that were installed in 1945. Two of these digesters, nos. 1 and 5, were taken out of service early in 1949 after complete tests with the Audigage revealed that they were dangerously thin. After these two digesters had been removed efforts were begun to prolong the life of the three remaining vessels which were also installed in 1945. Therefore, regular thickness tests were started at approximately 3-month intervals, and in conjunction with these tests a study was begun on the effect that cooking liquor constituents has on shell corrosion. Digester cooking data and vessel specifications are:

J. C. HAIR, Production Manager, and A. W. DUSKIN, Technical Service Director, Crossett Paper Mills, Crossett, Ark.

Operating Conditions:

Time to pressure	1 hr. 20 min.
Time at pressure	2 hr. 25 min.
Maximum pressure	100 lb.
Type of wood	100% pine
Liquor volume	1200 cu. ft. (total)
Per cent sulphidity	18 to 24%
Pounds of active alkali per ton	600 to 640 (total)
Method of cooking	Direct
Steam per cook	3000 to 3500 lb.

Vessel Specifications:

Size—10 ft. 6 in. diameter; 40 ft. 6 in. over-all height
Steel—Type A.S.T.M. A-70, tensile strength 55,000 p.s.i. Vessels fabricated and tested in accordance with A.S.M.E. Code U-68 for unfired pressure vessels for working pressure for 150 p.s.i.

The Use of Silicates

The addition of sodium silicate (42° Bé commercial water glass) to one digester was begun in Feb., 1950. We were rather cautious at first in the use of this material because of the detrimental effect that silicate bearing black liquor might have on evaporator efficiency. However, it was felt that since the silicate was only being added to one digester that the build-up in the liquor system would not be too rapid. At first the amount used was 5 gallons per cook in one digester and after about 2 weeks' time it was increased to 15 gallons per cook. The 15 gallons of sodium silicate per cook is equivalent to approximately 600 p.p.m. of SiO_2 in the white liquor. Daily tests were made on the black liquor from the digester to which the silicate was being added and also on the black liquor going to the evaporators. These tests were made using a photoelectric colorimeter that had been calibrated with known silica standards using ammonium molybdate as the indicator.

After the silica content of the liquor system had been built up, it was found that approximately 475 p.p.m. of silica were contained in the black liquor from no. 3 digester and 300 p.p.m. of silica in the liquor being fed to the evaporators. This concentration of silica apparently had no detrimental effect on our evaporator efficiency.

After the sodium silicate had been used for about 6 months it was found upon inspection of the digesters that very little if any, scale was being formed on the inside of the digester shell. Since the work of Benedicks indicated that a scale containing both silica and aluminum was necessary for a good protective coating, the addition of a clay called "Gleason's Clay" was begun. This material contained 57.8% silicon dioxide, 27.3% aluminum oxide, and 1.4% iron oxide, and was added along with the salt cake to the recovery furnaces. This clay was a very fine pottery type clay, free of lumps, and mixed well with the salt cake. This material was used for 5 weeks at a rate of 300 pounds per day along with the addition of sodium silicate to the digester. The use of the clay did help build up the silica content of the cooking liquors but before any appreciable scale could be deposited on the inside of the digesters, it was necessary to discontinue its use. The very fine nature of the clay caused the material to be swept up along with the fly ash into the tube section of the recovery boiler forming a hard deposit on the tubes that could not be removed by the tube blowers. Therefore, due to this formation on the boiler tubes and difficulties encountered with its removal, it was decided to discontinue the use of clay.

During the time clay and sodium silicate were being used, only a small amount of scale was observed in the digesters and this was encountered only in one small patch near the cone. An analysis of this scale showed:

Fe_2O_3	0.25%
Al_2O_3	4.17%
$CaCO_3$	89.50%
SiO_2	1.30%
SO_4	4.70%
Na_2O	1.04%

Based on the evidence Benedicks discovered, this is a poor scale containing insufficient quantities of aluminum or silica for a good quality protective coating.

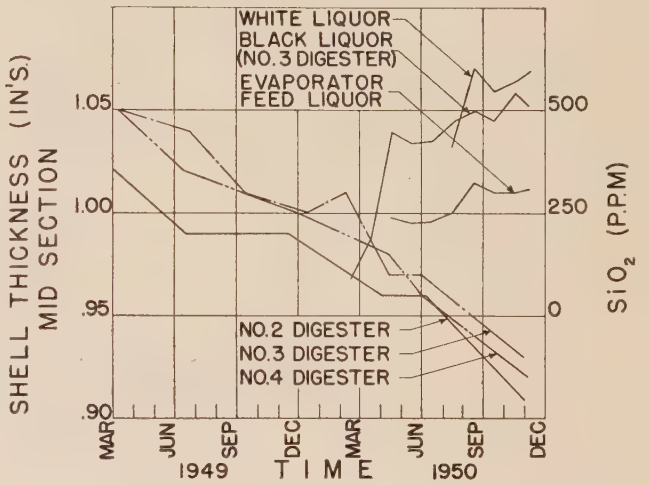

Fig. 1

There is shown in a graph in Fig. 1 the rate of corrosion for digesters 2, 3, and 4 and also the silica content of cooking liquors used during this period. The thickness measurements shown as the ordinate on this graph represent average readings taken on an area 9 feet high around the mid-section of each digester. Note that the metal depletion continued at almost a constant rate during the entire period with the increasing silica content of the liquor having no apparent effect.

In regard to the effect silica-bearing black liquor had on our evaporators, it is interesting to note that apparently the silica had no detrimental effects on evaporator efficiency and may have tended to increase tube life. The average tube life for evaporator effects 1A and 1B for the past 5 years had been 8.5 and 8.1 months, respectively. This is on a five-body, four-effect Swenson set. Tube life during the period when SiO_2 was being added to the liquors was 10 and 12 months, respectively. However, this increase in life over the average cannot be taken as conclusive.

Table II. Digester Penetration Rate
(Feb., 1950 -Nov. 1, 1950)

Digester No.	Age — 1000 Cooks	Age — Years	Thickness thinnest spot, in.	Average thickness,[a] in. At start	Average thickness,[a] in. Final	Penetration In./yr.	Penetration In./1000 cooks
2	1.58	0.701	0.65	0.97	0.91	0.086	0.038
3	1.62	0.717	0.67	1.01	0.93	0.111	0.049
4	1.58	0.701	0.60	0.99	0.92	0.100	0.044

[a] Cylindrical section 9 feet high in middle of digester wall.

The cost of adding sodium silicate to our system was 7 cents per ton of pulp produced. The clay additions which supplied about 10% of the total silica to the system cost 1 cent per ton of pulp.

Table II shows the penetration rate of the three digesters covering the period during which silica was being added to the liquors. Note that the corrosion rate per 1000 cooks for the period under study practically equalled the original corrosion rate shown in Table I, in the case of digester no. 2, and exceeded the original rate in the case of digesters nos. 3 and 4. The thinnest spot was not used in considering the corrosion rates, because patches had been placed in all three digesters over the thinnest areas in order to arrest the corrosion rate at these points.

CONCLUSIONS

Although previous work by Benedicks and Von Essen indicates that silica in sulphate digester cooking liquors aids the formation of scale and perhaps inhibits digester corrosion, this mill scale study, covering a 9-month period shows no beneficial effects from the use of silica added to the cooking liquor as sodium silicate. The silica content of the white liquor was increased to 600 p.p.m., and that of the liquor fed to the evaporators was increased from 225 to 310 p.p.m. of silica without detrimental effects upon the evaporators.

The use of (pottery) clay (mixed with salt cake and fed to the recovery furnace) as a source of silica is satisfactory chemically, but deposits on the boiler tubes caused by the clay decreased boiler efficiency and increased boiler tending problems.

While we do not presume to claim that it is impossible to form a protective scale in digesters by the use of silicates, we have proved to our satisfaction that adding sodium silicate in reasonable concentrations to digesters, will not form such protective scale. We only hope that our work will be used as a guide to anyone else attempting to form such a protective scale.

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Dissolving Pulp from Bamboo

M. H. JOGLEKAR and C. P. DONOFRIO

The findings in this investigation demonstrate that a highly satisfactory alpha pulp which may be utilized for dissolving purposes can be manufactured from bamboo through a series of chemical treatments consisting of acid prehydrolysis, sulphate digestion, and multistage bleaching. By virtue of its chemical composition, i.e., high fractions of pentosans and silica, bamboo posed many difficulties in pulp purification when the conventional pulping procedures were employed as initial steps in alpha pulp preparation. Alkaline pulps (soda and sulphate) exhibited high residuals of the above-mentioned constituents which resisted removal in many of the wide array of methods established for pulp purification. The matter of pentosans suggested a strong similarity between the alkaline bamboo pulps and the alkaline pulps produced from our more common hardwoods. Although low in residual pentosans, the bamboo sulphite pulps (prepared under carefully selected conditions) were found unsuitable for subsequent purification because of their highly degraded nature, high silica content, and inferior bleaching characteristics. Acid prehydrolysis of bamboo was found to be highly effective in facilitating the removal of pentosans and silica in the subsequent sulphate digestion stage. Pulps produced in this manner were bleached to high brightness levels with ease and with low total consumption of chlorine (less than 4%) in two or three stages. Because of the high degree of purity secured in these pulps the conventional alpha treatment was unwarranted. The suitability of sulphuric acid as the hydrolyzate and its reuse in the prehydrolysis of bamboo are discussed. Excellent acetate syrups of low turbidity and clear films were prepared from the bleached, prehydrolyzed bamboo pulps.

Outstanding among the potential sources of cellulose is bamboo, a rapidly growing monocot which has been utilized to only a limited extent since the beginning of papermaking when it, presumably, constituted the chief source of papermaking fibers. India, mostly because of necessity, is the only country which has developed a relatively small pulping industry utilizing this woodylike plant and as a result has learned that it possesses many attributes. Pulp manufacturers in this country are beginning to recognize these same attributes more and more; this is attested by increasing experimentation in growing and pulping bamboo. In the light of our dwindling wood supplies, this course of action is warranted.

In India, a country endowed with only scant and inaccessible stands of pulpwood, the utilization of bamboo for papermaking has been given considerable impetus by the investigations of Raitt (*10*, *11*) and Sindall (*12*). At the present time the two-stage alkaline process developed by the Forest Research Institute at Dehradun, India, is being commercially exploited (*1*). Through this process pulps comparable to our domestic kraft pulps in yield, strength, and tear, are being manufactured from several indigenous species of bamboo. The success of this development is attributed to the selection of those bamboo species which resemble wood in their properties (Table I). Of the estimated 1000 or more bamboo species many characterize the grasses in that they contain high fractions of silica and pentosans and low percentages of cellulose. In his work

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Raitt has substantiated the earlier findings of Cross and Bevan (*3*) which pointed out that bamboo yields most suitably to the alkaline digestion processes.

The prolificness with which bamboo grows is affirmed by Sindall (*12*) who estimated that with a 3-year cropping system 1 acre will yield 15 tons of bamboo annually. For certain bamboo species this represents a potential yield of cellulose almost equal to that obtainable from the same tonnage of spruce (Table I).

From the foregoing it becomes apparent that bamboo is an outstanding raw material which can be relied upon as a continuous source of supply and consequently, one which merits further investigation for extending its usefulness. Along these lines, the possibility of manufacturing dissolving pulp from bamboo is of special interest.

Table I. Analysis of Bamboo and Other Fibrous Raw Materials, Raitt (*10*)

Fibrous material	*Air-dry basis*						
	Starches, %	*Pectins, %*	*Lignin, %*	*Cellulose, %*	*Ash, %*	*Fats and waxes, %*	*Pulp yield, %*
Bamboo, *Bambusa arundinacea*	5.5	20.1	15.2	49.2	2.56	1.05	42.0
Bamboo, *Dendrocalamus strictus*	5.1	16.4	15.3	53.2	..	..	44.4
Bamboo, *Melocanna bambusoides*	3.2	17.4	15.5	43.9	3.05	..	45.6
Bamboo, *Ochlandra brandisii*	5.5	20.5	14.9	49.1	3.00	..	47.9
Esparto, *Lygeum spartum*	9.2	29.2	5.6	46.0	3.84	2.50	44.5
Wheat straw	7.8	27.6	8.3	46.4	2.70	1.24	..
Spruce wood	4.0	2.7	32.2	49.1	0.05	..	..

The specifications established by various authors for a suitable viscose pulp are given in Table II (*4*, *9*). In the light of these specifications and the chemical analyses of various bamboo species reported in the literature (Table I) it became obvious that great emphasis would have to be placed on chemical treatments which would facilitate adequate removal of the high fractions of pentosans and silica inherent to bamboo.

Table II. Chemical Characteristics of a Suitable Viscose Pulp

Alpha-cellulose, %	greater than 88.0
Pentosan content, %	less than 5.0
Lignin content, %	less than 0.15
Ash content, %	less than 0.15
Alcohol-benzene solubility, %	less than 0.5
Viscosity (TAPPI), cp	1 to 25
Brightness (Higgins), %	greater than 85

EXPERIMENTAL WORK

Two main phases of experimental work were undertaken in this investigation. The first was confined to a study of chemical refining of bamboo pulps produced by the conventional pulping procedures. Most of the pulp purification work was based on two-stage treatments consisting of an acid-hydrolysis stage followed by an alkaline-extraction stage. Through these treatments it was attempted to secure a high alpha pulp low in pentosans and silica. The effects of purification conditions on the removal of these components were determined.

The refined pulps produced in the second phase of work resulted from a series of chemical treatments consisting of acid prehydrolysis, alkaline digestion, and bleaching. The effects of sulphuric acid concentration employed in prehydrolysis and the effects of prehydrolysis temperature on the removal of pentosans and silica were determined. No variations were introduced into the alkaline digestion stage. Various bleaching methods and combined bleaching and alkaline-extraction methods were investigated in the final refining of the prehydrolyzed bamboo pulps. Within this same phase of work the effects of hydrolyzate reuse on the final pulp properties were determined.

The preparation of acetate syrups and films constituted only a minor phase of work in this investigation.

Materials and Procedures

Bamboo. The bamboo employed in this investigation was obtained from the Edison Winter Home, Fort Meyers, Fla. The hollow culms which were received in an air-dry state averaged about 6 feet in length and about 3.25 inches in diameter. No information was supplied about the identity of the species. Careful examination of the bamboo under the microscope failed to bring out any characteristic anatomical features by which it could be identified.

After soaking for 12 hours the bamboo culms were fed into a 24-inch laboratory chipper set to cut $^3/_8$-inch chips. Oversized chips, epidermal strips, and fines were removed by passing the chips over a laboratory vibrating chip screen. The water soaking of the bamboo before chipping avoided splitting of the culms under the impact of the chipper knives. After air-drying the acceptable chips were stored in air-tight fiber drums from which portions of known moisture content were withdrawn as required.

Table III. Proximate Analysis of Bamboo Under Investigation, Moisture-Free Basis

Ash, %	2.23
Alcohol-benzene solubility, %	9.10
Hot-water solubility, %	16.17
One per cent alkali solubility, %	39.57
Holocellulose, %	57.66
Alpha-cellulose, %	40.05
Pentosans, %	18.32
Lignin, %	19.57

Analysis of Bamboo. A composite sample of bamboo was reduced to fines in a Wiley Mill equipped with a 60-mesh screen. In accordance with TAPPI Standard procedures the following analysis of bamboo was obtained on the fines passing through the 60-mesh screen (Table III).

The analysis revealed that the bamboo under investigation differed considerably in its properties from the more suitable papermaking species of bamboo grown in India. High percentages of water solubility and alkali solubility, as measured in this species, are peculiar to the grasses (Table I).

duced from bamboo under the conditions indicated in Table IV and Fig. 1. In preparing the kraft pulp the two-stage alkaline digestion process developed at Dehradun, India, was employed. The conditions for the sulphite cook were selected from the work of Bhargava (*1*) in which it was concluded that bamboo can be

Table IV. Properties of Preliminary Sulphite and Kraft Pulps Produced from Bamboo

		Factors		Pulp properties				
Cook no.	*Type*	*Maximum burst, pt./lb.*	*Tear at maximum burst, pt./lb.*	*Double folds (Schopper)*	*Breaking length, meters*	*Ash, %*	*1% NaOH solubility, %*	*$KMnO_4$ no.*
1	Sulphite	0.85	0.92	637	5600	1.14	17.68	39.8
3	Kraft	1.40	1.48	2124	9300	1.68	6.04	12.9

Sulphite Cooking Conditions:
Cooking liquor ratio, 6/1
Total SO_2, 6.1%
Combined SO_2, 1.6%
Magnesium base
Maximum pressure, 74 p.s.i.

Kraft Cooking Conditions:
Stage 1
Active Na_2O on moisture-free wood basis, 8.63%
Liquor ratio, 5/1
Sulphidity, 0%
Stage 2
Active Na_2O on moisture-free wood basis, 15.6%
Liquor ratio, 3/1
Sulphidity, 33%

Sulphite Pulping Procedure. The sulphite pulping of bamboo was carried out in accordance with the procedure in use at the College of Forestry, State University of New York, and is described completely by Feola and Libby (*5*).

Alkaline Pulping Procedure. The alkaline pulping procedure as described by Tasker and Libby (*13*) was employed for preparing the soda and kraft pulps from bamboo. This procedure is in use at the above-mentioned institution.

Methods of Evaluating Pulps. All pulps with the exception of the single sulphite pulp were evaluated for their chemical properties in accordance with the following TAPPI Standard Procedures:

1. Ash ..... TAPPI Std. T 211 m-44
2. Alcohol-benzene solubility ..... TAPPI Std. T 6 m-45
3. One per cent NaOH solubility ..... TAPPI Std. T 212 m-44
4. Pentosans ..... TAPPI Std. T 223 m-48
5. Alpha-cellulose ..... TAPPI Std. T 203 m-44
6. Ash in alpha-cellulose ..... TAPPI Std. T 203 m-44
7. Lignin ..... TAPPI Std. T 222 m-43
8. Permanganate number ..... TAPPI Std. T 214 m-42
9. Viscosity (falling sphere method using cupriethylenediamine after sodium chlorite treatment) ..... TAPPI Std. T 230 m-46

In addition to the chemical tests listed above the bleach requirements of the bamboo pulps were determined by a single-stage hypochlorite bleach method designated as "Excess Chemical Method" at the College of Forestry, State University of New York. The complete procedure is reported by Tasker and Libby (*13*).

Only the pulps resulting from the preliminary work were analyzed for their physical properties. The factors listed below were determined in accordance with TAPPI Standard Procedures T 205 m-45 and T 220 m-45: (1) bulk, (2) bursting strength, (3) tensile strength, (4) tearing resistance, and (5) folding endurance (Schopper).

EXPERIMENTAL RESULTS—PART I

Preliminary Pulping Experiments

Cook no. 1 (sulphite) and cook no. 3 (kraft) were pulped satisfactorily by the sulphite process using a magnesium-base cooking acid.

The kraft pulp (cook no. 3) was found to be superior to the sulphite pulp (cook no. 1) in all respects (Table IV). Aside from being completely unsatisfactory for bleaching purposes the sulphite pulp exhibited a high

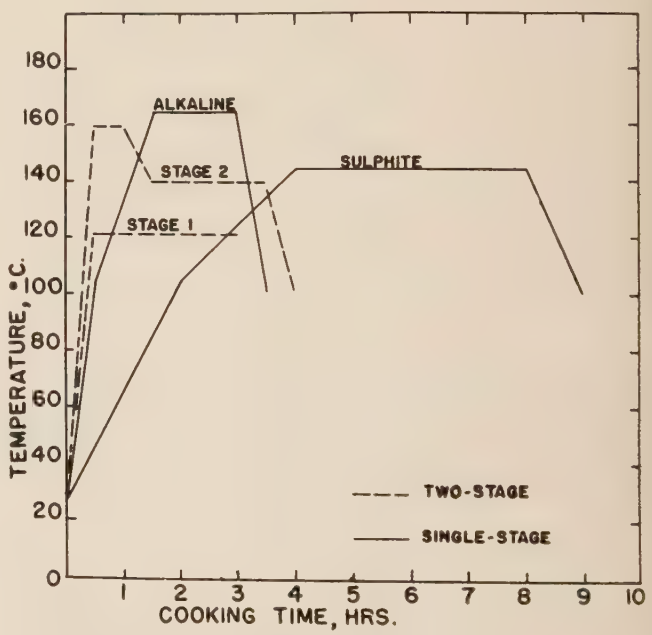

Fig. 1. Time-temperature schedules for bamboo pulping procedures

alkali solubility (1% NaOH) and a highly degraded cellulose fraction. The observations made on strength properties of the alkaline pulps indicated the desirability of bamboo for papermaking purposes; the properties suggested a pulp comparable in strength to the kraft pulps produced from the more common coniferous woods. As a consequence of the findings obtained in the preliminary pulping trials the emphasis in the subsequent work was placed on the alkaline digestion of bamboo.

Alkaline Pulps from Bamboo

A series of four cooks, two soda (cooks nos. 4 and 6) and two kraft cooks (cooks nos. 5 and 7), was carried out employing the conventional single-stage digestion process (Table V, Fig. 1). The kraft pulps were found to be superior to the soda pulps in bleaching characteristics; for a 10% consumption of chlorine (single-stage hypochlorite) the kraft pulps were bleached to a brightness of about 80% (Higgins) while the soda pulps were bleached to a level of about 70%. Accordingly the lignin content of the kraft pulps was found to be appreciably lower than that of the soda pulps.

All alkaline pulps exhibited in common the following adverse factors: low yield (33 to 40%), high ash content (1.4 to 1.7%), and a high pentosan content (16 to 18%). With respect to these factors it should be recalled that the bamboo under investigation was far different in properties from the species of bamboo now being utilized with much success in India. For the latter Bhargava (*1*) has reported yields of 43 to 48% (air-dry basis). The differences which account for the disparity in yield, however, would not alter the important issue at hand. Regardless of yield, the undesirable constituents, pentosans and silica, in the bamboo alkaline pulps must be removed in order to secure pulps suitable for dissolving purposes.

Table V. Chemical Analysis of Alkaline Bamboo Pulps

		Moisture-free wood basis			Moisture-free pulp basis								
		Active	Yield			Alcohol-benzene,	1% NaOH				Viscosity	Ash in	
Cook no.	Type	Na_2O, %	Total, %	Screened, %	Ash, %	solubility, %	solubility, %	Pentosans, %	Lignin, %	Alpha-cellulose, %	$Cu(En)_2$, cp.	alpha-cellulose, %	Brightness,[b] %
6	Soda	16	41.3	39.5	1.41	0.0	4.6	16.4	4.46	85.1	640	0.58	66
4	Soda	20	37.6	36.3	1.67	0.0	5.1	15.4	3.56	85.6	392	0.79	68
7	Kraft	16	38.6	32.7	1.29	0.0	4.9	17.6	2.84	80.8	967	0.48	78
5	Kraft	20	38.3	37.3	1.37	0.4	5.4	16.5	2.24	78.0	575	0.46	82
3	Kraft[a]	..	33.5	32.5	1.63	0.0	6.0	15.4	1.86	84.2	438	0.60	78

[a] Two-stage kraft cook, Table IV.
[b] Brightness (Higgins) for 10% consumption of active chlorine.
Liquor ratio, 7/1. Sulphidity in kraft cooks, 33% .

necessary treatments for the purification of alkaline pulps (hydrolysis of pentosans) no further attempts were made to remove ash in separate pulp treatments.

Tasker and Libby (*13*) had demonstrated that a suitable viscose pulp could be prepared from alkaline hardwood pulps (maple) high in pentosan content by a two-stage treatment consisting of acid hydrolysis (HCl) and an alkaline-extraction stage. The pulp resulting from cook no. 5 was treated under conditions found to be optimum in the above-mentioned work. The results are indicated under experiment no. 1 (Table VI). Although the ash constituents were reduced to a low value (0.14%) the pentosan content of the refined pulp (7.0%) was determined to be considerably higher than that allowable for a dissolving pulp. In subsequent purification trials accomplished on the same pulp the effect of temperature of the alkaline-extraction treatment was studied (Table VI). Lowering of the temperature was found to confer no favorable effect in removing the resistant pentosans.

Table VI. Effects of Purification Treatments on Bamboo Kraft Pulp

		Stage 1				Stage 2				Moisture-free pulp basis	
		Moisture-free pulp basis	Consistency,			Moisture-free pulp basis	Consistency,				
Expt. no.	Chem. used	Chem., %	%	Temp., °C.	Time, hr.	NaOH, %	%	Temp., °C.	Time, hr.	Ash, %	Pentosans, %
1	HCl	20	5.0	90	2	100	10.0	25	8	0.14	7.0
2	HCl	20	5.0	90	2	100	10.0	0	8	0.53	8.4
3	Cl_2	5.0	5.0	40	6	20	5.0	25	6	..	15.4
4	Cl_2	5.0	5.0	40	6	40	5.0	25	6	..	13.4
5	Cl_2	5.0	5.0	40	6	40	5.0	100	6	..	14.1
6	Cl_2	5.0	5.0	40	6	60	5.0	25	6	..	11.1
7	Cl_2	5.0	5.0	40	6	80	5.0	25	6	..	8.3
8	Cl_2	5.0	5.0	40	6	80	5.0	100	6	..	9.5
9	Cl_2	5.0	5.0	40	6	100	5.0	25	6	..	7.1

Purification of Alkaline Bamboo Pulps

Attempts were made to remove the ash constituents by physical means, namely, settling and flotation techniques. These attempts, however, proved unsuccessful. The only suitable manner found to effect ash removal pointed to an acid treatment of the pulp; about 79% of the ash was found to be soluble in dilute hydrochloric acid. As acid hydrolysis constitutes one of the

In the purification trials that followed a chlorination stage was employed in place of the acid-hydrolysis stage (Table VI). All pulp specimens taken from cook no. 5 were chlorinated under identical conditions. For the subsequent alkaline-extraction stage the amount of alkali applied and the temperature of extraction were varied. The results of these experiments revealed that the extent of pentosan removal was dependent upon the quantity of alkali employed in the extraction stage. Applications of alkali as high as 100%, however, failed to bring about a satisfactory reduction in the pentosan fraction. Chlorination was found to be as effective as the acid-hydrolysis stage using hydrochloric acid. However, a fraction of the pentosans (greater than 5.0%) appeared to be completely resistant to the hydrolytic

action of both agents and to the subsequent action of the alkaline-extraction stage.

PART II

Preliminary Prehydrolysis Experiments

Three small-scale experiments were conducted in which 20-gram specimens of bamboo chips were refluxed with 500 ml. of dilute H_2SO_4 at concentrations of 8, 16, and 24 grams per liter, respectively. After refluxing for 2 hours the chips were washed, air-dried, and extracted with 500 ml. of NaOH solution (60 g./l.) for 2 hours. The final product was washed, air-dried, and reduced to fines in a Wiley mill. Pentosan determinations which were conducted on the fines are reported below.

H_2SO_4, g./l.	Pentosans, %
8	8.1
16	5.8
24	3.9

Further investigation along these lines indicated that the pentosans were not removed during the prehydrolysis treatment of the chips but were converted into shorter chain lengths which facilitated removal in the subsequent alkaline treatment.

Alkaline Digestion of Prehydrolyzed Bamboo

On the basis of the preliminary prehydrolysis experiments standard laboratory size trials were established; 3 kg. of bamboo were first submitted to acid hydrolysis in dilute sulphuric acid and then digested by the alkaline process. In carrying out these trials a horizontal, lead-lined rotary digester, fabricated from 10-inch iron pipe, was employed. One flange to which a temperature well was attached was permanently fixed; the other flange, a removable one, was fitted with a relief valve and a pressure gage. The digester was turned at about 1.5 r.p.m. on idlers through a gear reduction unit driven by an electric motor. Heat was supplied to the unit externally by means of Meeker burners.

A 4 to 1 liquor ratio based on the moisture-free weight of bamboo chips was established for all prehydrolysis trials. Of the total 2.5 hours of reaction time 1 hour was utilized in raising the temperature of the digester contents to the level desired for prehydrolysis. At the end of the treatment the digester was discharged and the waste liquor was allowed to drain from the chips. After washing the chips as free as possible of residual acid, they were allowed to air-dry. The moisture content of the dry hydrolyzed chips was determined and the yield was ascertained.

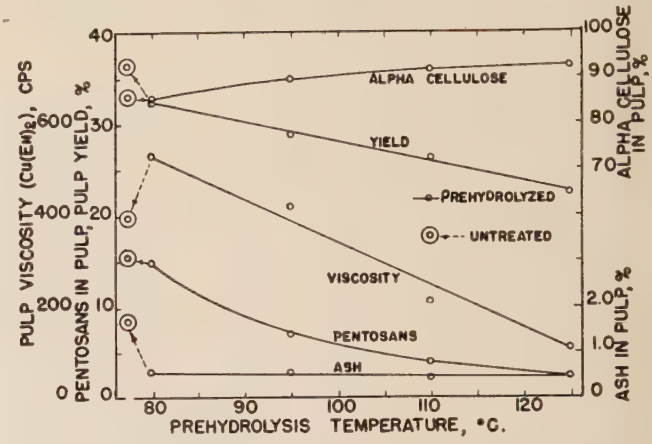

Fig. 2. The effects of H_2SO_4 concentration on the properties of soda pulps produced from prehydrolyzed bamboo

The subsequent alkaline digestion stage was accomplished under the conditions listed in Table VII and Fig. 1.

Two series of prehydrolyzed pulps were prepared; one in which the concentration of sulphuric acid for prehydrolysis was varied and one in which the temperature of prehydrolysis was varied (Table VII, Fig. 2). No variations were introduced into the alkaline digestion stage.

Table VII. Summary of Pulping Results on Untreated and Prehydrolyzed Bamboo

	Prehydrolysis stage			Pulp properties after alkaline digestion stage							
						Moisture-free pulp basis					
Expt. no.	Acid conc., g./l.	Temp., °C.	Yield, %	Type of cook	Pulp[a] yield, %	Alpha-cellulose, %	Pentosans, %	Ash, %	1% NaOH solubility, %	Viscosity Cu(En)2, cp.	Brightness,[b] %
4	..	..	..	Soda	36.3	85.6	15.4	1.70	5.1	392	68
5	..	..	..	Kraft	37.3	78.0	16.5	1.37	5.4	457	82
H-2	10.7	110	84.0	Soda	31.0	88.9	8.8	0.50	1.5	423	77
H-3	20.8	110	75.0	Soda	26.0	91.7	3.7	0.39	2.0	203	82
H-4	31.2	110	71.7	Soda	23.5	91.7	3.0	0.42	3.0	170	76
H-5	20.0	95	81.2	Soda	28.7	89.4	6.9	0.52	0.0	417	..
H-6	20.0	80	89.5	Soda	32.4	85.4	14.9	0.54	0.0	525	..
H-7	20.0	125	72.0	Soda	22.5	92.2	2.2	0.45	2.6	104	..
H-9	20.0	110	..	Kraft	26.4	93.5	4.6	0.40	..	457	86

[a] Original moisture-free wood basis.
[b] Brightness (Higgins) for 10% consumption of active chlorine.
Prehydrolysis Stage:
Liquor ratio, 4/1
Time at maximum temperature, 1.5 hr.
Alkaline Digestion Stage:
Liquor ratio, 7/1
Active Na_2O on moisture-free prehydrolyzed wood basis, 20%
Sulphidity for kraft cooks, 33%
Time-temperature schedule, Fig. 1

Effect of Hydrolyzate Concentration on Pulp Properties

As the concentration of sulphuric acid employed for prehydrolysis was increased the pentosan content of the resulting alkaline pulps was observed to decrease; however, no advantages in pentosan removal were secured in exceeding the acid concentration of 20 grams per liter. The latter concentration was found necessary for reducing the pentosan fraction below the limit allowable in a viscose pulp. With increasing acid con-

centration the decrements in pulp yield were found to parallel those observed in pentosan removal. These factors, however, inflicted slight, if any, alterations on the alpha-cellulose content of the resulting pulps. The viscosity of the prehydrolyzed pulps was found to decrease with increasing acid concentration. From the above observations it was assumed that the main cellulose fraction was attacked along with the pentosans and that this action became more severe as the acid concentration was increased.

The prehydrolysis treatment was found to confer a favorable effect upon the removal of ash constituents. The extent of removal, however, was not completely

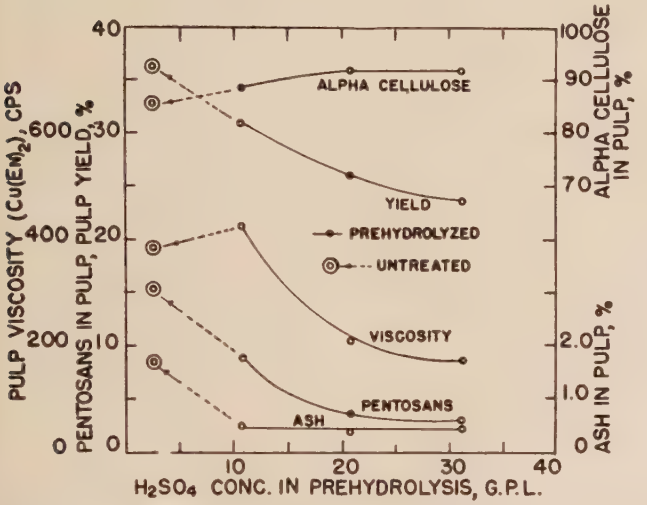

Fig. 3. The effects of prehydrolysis temperature on the properties of soda pulps produced from prehydrolyzed bamboo

satisfactory; most prehydrolyzed pulps exhibited an ash content of about 0.4 to 0.5% which is excessive for viscose-type pulps. No significant changes in the ash content of the prehydrolyzed pulps were observed over the range of sulphuric acid concentration investigated for the prehydrolysis treatment.

Temperature Effect in Bamboo Prehydrolysis

In all trials established to investigate the effect of prehydrolysis temperature over the range of 80 to 125°C., the concentration of sulphuric acid was maintained at 20 grams per liter (Table VII, Fig. 3). As evidenced by a comparison of final pulp properties the effects of increasing prehydrolysis temperature appeared to be similar to those observed for increasing acid concentration. This, of course, is as expected since both factors are functions of the reaction rate. No advantages in the final pulp properties were secured at prehydrolysis temperature levels greater than 110°C.

Another function of reaction rate would be found in the degree of dissociation of the acid or acid salt employed for prehydrolysis. All other factors being equal, the more dissociated an acid the more rapid the rate of hydrolysis of the carbohydrate constituents. It follows then that hydrochloric acid should promote the most rapid rate of reaction for prehydrolysis. In an extensive study on the prehydrolysis of wood Correns (*2*) proved this to be true.

Upon completion of the prehydrolysis treatment the hydrolyzate must be removed. The last traces become difficult to remove through the ordinary washing procedures. On a commercial scale of operations the washing action would be even less efficient. Thus any residual acid in the chips would lead to the formation of the corresponding salt when the chips are submitted to the alkaline digestion stage. In this connection the use of sulphuric acid would be of advantage as the salts it forms can be utilized as a source of active chemical for sulphate digestion; for most of the other effective acids, the resulting salts would be inert. Moreover, their concentration would build up to a possible disadvantage in the recovery system.

Kraft Pulp from Prehydrolyzed Bamboo

A kraft digestion (cook no. H-9) was accomplished on bamboo chips which were prehydrolyzed under the conditions found optimum in the earlier work (Table VII). It will be recalled that all of the earlier alkaline digestions on prehydrolyzed bamboo were of the soda type. A comparison of the pulp from cook H-9 with the prehydrolyzed soda pulp from cook H-3 which was conducted under identical conditions, indicated that the former was significantly superior in alpha-cellulose content and in bleaching characteristics. The kraft pulp indicated a slightly higher pentosan content but this was below the limit allowable in a viscose-type pulp. Further comparisons between prehydrolyzed pulps and pulps produced from untreated bamboo under identical alkaline digestion conditions revealed that apart from improvements in pentosan and silica removal, the prehydrolysis treatment brought about a noteworthy reduction in the bleach requirements. In the bleachability plots relating brightness and chlorine consumption, it was observed that the points of inflection and accordingly the brightness levels were much higher for the pulps ensuing from the prehydrolysis treatment.

Refining Prehydrolyzed Bamboo Pulps

The pulp resulting from cook no. H-9 (kraft cook on prehydrolyzed bamboo chips) was selected for the purification study because of its favorable bleaching characteristics. Also in the unbleached state, it was found to conform with all of the specifications of a suitable viscose pulp except that it possessed a higher ash content (0.4%).

In preliminary bleaching trials conducted on the above pulp it was found that about 7.0% chlorine was required in a single-stage sodium hypochlorite treatment for obtaining a final brightness of about 85% (Higgins).

In a two-stage bleaching trial (chlorination and hypochlorite stages) the total bleach requirements were reduced to slightly over 5.0% (available chlorine) for achieving the same brightness level indicated above. Further investigations in two-stage bleaching demonstrated that the optimum level of chlorine application for chlorination was 3.0% available chlorine (moisture-free pulp basis).

On the basis of the findings obtained in the above work a series of purification experiments was conducted utilizing bleaching and combined bleaching and alpha treatments (Table VIII). The designation used for identifying these purification experiments is explained below.

No.	Designation	Description
P-1	B	Single-stage sodium hypochlorite bleach
P-2	CNB	Chlorination, caustic extraction, sodium hypochlorite bleach
P-3	$CNBA_5$	Same as P-2 followed by an alpha treatment (A) applying 5% NaOH on the weight of moisture-free pulp
P-4	$CNBA_{10}$	Same as P-3 but with 10% NaOH on the same basis
P-5	CA_5B	Chlorination, alpha treatment with 5% NaOH on moisture-free pulp and sodium hypochlorite bleach
P-6	$CA_{10}B$	Same as P-5 but with 10% NaOH on the same basis

In all cases 3% available chlorine was applied and consumed in the chlorination stage. Washing was applied after each stage of purification and following the washing subsequent to the final stage, the bleached pulp was steeped for $^1/_2$ hour in a dilute solution of sulphur dioxide (pH 4.5) at a consistency of 3%. At the completion of the post-treatment the pulp was washed, air-dried, and analyzed.

The conditions under which the various treatments were accomplished were as follows:

Chlorination (C)	
Consistency, % (moisture-free pulp basis)	3.0
Temperature, °C.	25.0
Time, hr.	1.5
Alkaline Extraction (N)	
Consistency, % (moisture-free pulp basis)	10.0
Temperature, °C.	40
Time, hr.	1.0
NaOH applied, % (moisture-free pulp basis)	2.0
Sodium Hypochlorite Bleach (B)	
Consistency, % (moisture-free pulp basis)	5.0
Temperature, °C.	35.0
Time, hr.	6.0
pH	10.0–10.5
Alpha Treatment (A)	
Consistency, % (moisture-free pulp basis)	10.0
Temperature, °C.	50
Time, hr.	1.5

The results obtained in the above study indicated that adequate purification of the prehydrolyzed bamboo pulp could be secured through a three-stage bleach consisting of chlorination, alkaline extraction, and a sodium hypochlorite bleach (Table VIII). In experiments (P-3, P-4) where an alpha treatment was applied after three-stage bleaching of the type just described no significant extent of purification was achieved. When the alpha treatment was substituted for the alkaline-extraction stage (P-5, P-6) the alpha content of the final pulps was observed to be slightly lower than that of the pulp resulting from the three-stage bleach (P-2) incorporating the alkaline-extraction stage. Hence, a conventional three-stage bleach was found to be completely satisfactory for purifying the kraft pulp produced from prehydrolyzed bamboo.

It was observed that the variations in the purification treatments exhibited little, if any, effect on the total consumption of chlorine in bleaching. For all multi-stage treatments this factor was found to remain almost constant.

Low yield values were measured for all of the refined pulps produced in this investigation. It was felt, however, that this factor would not obviate the use of bamboo as a raw material for dissolving pulp. It will be recalled that the reasons for low yields were pointed out earlier in the discussion, namely, the inferior properties of the bamboo under investigation.

Table VIII. Summary of Data Obtained on Purification Treatments Conducted on Prehydrolyzed Bamboo Kraft Pulp (Cook H-9)

Expt. no.	Type of treatment	B-stage Added, %	B-stage Cons., %	Total Added, %	Total Cons., %	Brightness (Higgins), %	Pulp yield, %	Based on moisture-free purified pulp: Ash, %	Pentosans, %	Alpha-cellulose, %	Viscosity (TAPPI), cp.	Ash in alpha-cellulose, %
P-1	B	7.44	7.18	7.44	7.18	86	25.7	0.4	3.0	92.0	8.0	0.11
P-2	CNB	1.95	0.82	4.95	3.72	85	23.0	0.4	3.7	98.5	25.0	0.11
P-3	$CNBA_5$	1.95	0.82	4.95	3.72	82	23.0	0.4	3.6	99.0	22.0	0.11
P-4	$CNBA_{10}$	1.95	0.82	4.95	3.72	82	22.8	0.4	3.5	99.0	22.0	0.11
P-5	CA_5B	1.88	0.81	4.88	3.71	87	24.8	0.4	3.3	97.0	21.0	0.11
P-6	$CA_{10}B$	1.88	0.67	4.88	3.57	87	23.8	0.4	3.0	97.0	21.0	0.11
	Unbleached pulp	..	..	..	..	..	26.4	0.4	4.6	93.5	85.0	0.19

[a] Pulp yield on original moisture-free wood basis.
C-stage (all experiments): chlorine added, 3.0%; chlorine consumed, 2.9%.

In all of the refined pulps the ash content was determined to be higher than the limit specified for dissolving pulps. In all other respects, however, these pulps were found to meet the specifications of a rayon-grade pulp. Here again it was felt that a more suitable species of bamboo would have yielded completely satisfactory results. This view was justified by the very recent work of Karnik and Sen (*8*). Using hydrochloric acid for the prehydrolysis of Indian bamboos, these investigators produced pulps of low ash content (0.14 to 0.21%) in yields of 32 to 42%. The resulting pulps have been claimed to be suitable for the manufacture of viscose.

Reuse of Prehydrolysis Liquor

The possibility of reusing the waste acid resulting from the prehydrolysis treatment was investigated. An analysis conducted on the waste hydrolyzate resulting from several of the earlier investigations revealed that the concentration of sulphuric acid was unaffected by the prehydrolysis treatment.

The hydrolyzates resulting from three trials (nos. H-9, H-10, H-11) were combined and reused in prehydrolyzing the bamboo for cook nos. H-14 and H-15 (first reuse). The hydrolyzates which resulted from the latter were combined and reused in preparing cook no. H-16 (second reuse). All other prehydrolysis conditions were held constant (Table IX). The plan of operation just described was found necessary as an appreciable portion of the hydrolyzate was lost in discharging the digester.

The findings obtained in this study indicated that the waste acid could be reused only once, a second reuse was found to be only partially effective in breaking down the pentosans (Table IX).

Table IX. Effects of Hydrolyzate Reuse on Pulp Properties

Cook no.	Description of hydrolyzate	Pulp yield, %	Moisture-free pulp basis: Ash, %	Pentosans, %	Alpha-cellulose, %	Viscosity Cu(En)₂, cp.
H-9	Fresh acid	26.4	0.4	4.6	93.5	457
H-14	First reuse	26.9	0.4	5.3	94.0	794
H-16	Second reuse	27.2	0.6	10.6	87.6	1535

Prehydrolysis Conditions:
Concentration of H_2SO_4, 20 g./l.
Temperature, 110°C.
Time at temperature, 2 hr.
Liquor ratio, 4/1

All pulps of the series exhibited only slight variations in their yield values. In other words, for all cooks the same total quantity of carbohydrate material (holocellulose) was removed indicating that the same degree of hydrolysis was sustained throughout. On the other hand, the composition of the resulting pulps was found to be altered markedly in proceeding from the first to the second reuse of waste hydrolyzate. From these observations it appeared that the hydrolysis reactions were governed by a mass action effect, the extent to which a given constituent was acted upon appeared to be dependent upon the quantity and nature of the same constituent already in solution. For example, in reusing the hydrolyzate the hydrolytic action inflicted on the pentosan constituents became suppressed perhaps by the concentration of furfural yielding components already in solution. Nevertheless, the hydrolysis action was sustained at the expense of other carbohydrate constituents. Similar kinetic effects were manifested in the earlier relationships uncovered for other functions of reaction rate, viz., concentration and temperature.

ACETYLATION OF REFINED BAMBOO PULPS

The suitability of the refined bamboo pulps for acetylation was determined by a simple method recently proposed by Heuser (*6*). The pulp resulting from the purification treatment P-2 was selected for the determination. For comparative purposes similar experiments were conducted on purified cotton and on the pulp resulting from cook no. H-3 (prehydrolyzed soda pulp bleached with sodium chlorite). The syrups resulting from acetylation were tested for clarity using a Klett-Summerson Photoelectric Colorimeter equipped with a blue filter (spectral range, 400 to 465 mu). The results are shown below.

Specimen	Scale reading	Pulp/cotton scale reading ratio
Purified cotton	55	. .
Pulp no. H-3	212	3.86
Pulp no. P-2	140	2.55

Using a Pulfrich Photometer, Jayme and Schenck (*7*) found that the turbidity of a suitable dissolving pulp (alkaline refined sulphite pulp) was 8.8 times that of a cotton-linter pulp.

The cellulose acetate syrup produced from pulp no. P-2 was poured slowly into cold water with constant stirring. The primary cellulose acetate which precipitated out was filtered, washed, and allowed to air-dry.

On the basis of the triacetate, the yield of primary acetate was determined to be 95% of the theoretical.

The primary cellulose acetate produced was found to be completely soluble in chloroform but insoluble in acetone. The films prepared from the chloroform solution were clear, colorless, and transparent.

SUMMARY AND CONCLUSIONS

1. The bamboo under investigation was observed to respond more favorably to alkaline digestion than to sulphite digestion. The bamboo sulphite pulp was found to be degraded and difficult to bleach whereas the converse was observed in the alkaline pulps.

2. For purification purposes the alkaline pulps produced from bamboo were found to be objectionable. The inherently high fraction of pentosans and silica could not be reduced satisfactorily through moderate or drastic pulp purification treatments.

3. An easy bleaching pulp low in pentosan content was obtained when bamboo chips were prehydrolyzed (2% H_2SO_4, 110°C., 2.5 hours) and subsequently digested by the kraft process (20% active Na_2O, 33% sulphidity, 3.5 hours). No purification over that normally secured through a three-stage bleach (chlorination, alkaline extraction, sodium hypochlorite bleach) was required on this pulp.

4. The above-mentioned pulp exhibited the following properties: alpha content of 98.5%, pentosan content of 3.7%, viscosity of 25 cp. (TAPPI), brightness of 85% (Higgins), and an ash content of 0.4%. Except for ash content, this pulp met all of the specifications of a viscose pulp.

5. On acetylation the bleached kraft pulp resulting from prehydrolyzed bamboo chips produced a clear syrup of low turbidity. Films cast from the chloroform solution of the primary acetate were of excellent quality.

6. The prehydrolysis procedure for the manufacture of dissolving pulp from bamboo was found to be suitable and practical.

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Effect of Recycling Spent Liquor in Semichemical Pulping

E. L. KELLER and J. N. McGOVERN

A series of neutral sulphite semichemical digestions of quaking aspen was made in which the spent liquor from each digestion was collected and used in the next digestion after fortifying with additional cooking chemicals. All other digestion conditions were maintained constant. Approximately 85% of the total liquor in the digester at the end of the digestion was recovered, and 80% was reused. The specific gravity and total solids content of the spent liquor closely approached maximum or equilibrium values after 10 cycles of reuse. The equilibrium values after 11 cycles were 212 grams per liter of total solids with 114 grams per liter of sulphated ash in comparison with 76 and 44 grams per liter, respectively, after the first cycle. The pulp yield increased from about 74 to 76% in reaching this equilibrium and the pulp brightness decreased from 51 to 47%. The lignin content of the pulps increased slightly but their strength properties did not change during the recycling process.

THE reuse of the spent liquor in semichemical pulping is not uncommon practice (*4*). This reuse will return heat and a small amount of residual active chemicals to the digester as well as solids resulting from the reaction products of the pulping. The advantages of the heat and residual chemical recovery are obvious. The increase in the solids content of the spent liquor by recycling would be of great importance if it is to be used for the generation of heat through combustion, and the recovery of cooking chemicals. There appears to be no published information, however, on the effect of the reuse of the spent liquor on the pulping process itself, the properties of the spent liquor, or the yield and quality of the semichemical pulp. The present experiments were conducted at the Forest Products Laboratory to furnish such information.

The reuse of considerable portions of the black liquor in sulphate pulping and of the relief liquor in sulphite pulping is common practice with beneficial results. Such practices have been found in some instances to affect the pulping operation or the properties of the pulp so as to require modifications of the cooking conditions in order to obtain the over-all results desired. In sulphate pulping the addition of black liquor to the white liquor has been reported to give faster cooking and a slightly stronger pulp (*3*). In sulphite pulping the recirculation and addition of relief liquors from the first part of the digestion are the usual operations with improvement in penetration, shortening the cooking time, and heat recovery. Certain amounts of the waste liquor from the end of the digestion can apparently also be used with increase in cooking rate but with the possibility of reduced pulp brightness and increased bleach requirement (*2*). It has also been reported that in full sodium sulphite pulping (Keebra process) the spent liquor can be used as many as five times (*1*).

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EXPERIMENTAL

The scope of the investigation was limited to one species, quaking aspen (*Populus tremuloides*), and to one yield, approximately 75%. The experiments involved successive digestions with neutral sulphite liquor using fresh liquor at the start and collecting the free-draining and readily expressed spent liquor from the semichemically cooked chips for use as the cooking liquor for the next digestion after fortification to the starting active concentration with fresh sodium sulphite and sodium bicarbonate. This cycling was continued until equilibrium as measured by the total solids content of the spent liquor was substantially reached.

The digestions were made in a stainless steel, steam-jacketed, tumbling digester with a capacity of 0.8 cubic foot. About 7 pounds of air-dry aspen chips or 6.25 pounds on a moisture-free basis were used for each digestion. The chips were steamed in the digester at atmospheric pressure prior to adding the cooking liquor. This brought their moisture content to about 50%. The cooking liquor charge was 3.5 gallons and had a concentration of 36.5 grams per liter of sodium sulphite and 18.6 grams per liter of sodium bicarbonate. The ratio of cooking liquor (including the water in the chips) to the wood was thus about 6 parts to 1 part on a weight basis. The digester was heated indirectly to the cooking temperature of 170°C. in 1.5 hours and held at this temperature for 1.75 hours. The pressure was relieved once to 115 p.s.i. when 170°C. was reached. At the end of the cooking period the spent liquor was withdrawn from the digester through a cooler; the volume of the spent liquor averaged 3.3 gallons including the condensed liquid from the digester relief. The cooked chips were then pressed in a canvas bag in a hydraulic press at 90 p.s.i. for 10 minutes to remove additional spent liquor. This amounted to approximately 0.4 gallon and was added to the main supply of spent liquor.

After taking samples for testing, approximately 3.4 gallons of spent liquor were available for subsequent digestion. In preparing the cooking liquor after the first digestion, sufficient fresh water (0.1 gallon) and sodium sulphite and sodium bicarbonate were added to bring the liquor to the starting concentration and volume. On standing, a yellow deposit settled out. The liquor over this deposit was siphoned off for the digestion and the residue discarded. The cooking liquors were analyzed for their content of sodium sulphite and sodium bicarbonate and for pH by recently published methods (*5*). However, in order to minimize reaction of the iodine reagent with the organic matter present in the cooking liquors, the sulphite analysis was begun in the presence of 5 ml., rather than 2 drops, of 0.1 *N* acid as ordinarily used. The determinations of specific gravity, total solids, and inorganic solids as sulphated ash were made by standard TAPPI methods.

The cooked chips were fiberized in a laboratory-scale, single-rotating disk attrition mill and the pulp yield determined. The strength properties and chemical composition of the pulps were determined according to TAPPI methods. Test sheets for the brightness determination were made from pulp screened through 0.008-inch slotted screen plates.

DISCUSSION OF RESULTS

Total Solids Content and Some Properties of the Spent Liquor

The major factors fixing the equilibrium value for the total solids content of the spent liquor are, of course: (1) the extent of pulping in terms of pulp yield, (2) ratio of liquor to wood, (3) ratio of cooking chemical to wood, (4) solubility of pulping reaction products in the spent liquor (depending importantly on temperature), and (5) the proportion of the total dissolved solids recovered in the spent liquor. The main determining factors in the present experiments were, thus: (1) the pulp yield of about 75%, (2) the ratio of liquor to wood of 6 parts to 1 part on a weight basis, (3) the ratio of total cooking chemical to wood of approximately 0.15 part to 1 part, by weight, (4) the precipitation of a small, unmeasured amount of a ligneous material from the spent liquor on standing (discussed later), and (5) the reuse of 0.8 of the total volume of spent liquor and the presence of a small amount of concentrated reaction products within the chips apparently not in equilibrium with the spent liquor. A theoretical equation for the increase in total solids with recycling the spent liquor was developed as follows:

Table I. Total Solids Content of Spent Semichemical Liquors[a]

Ratio of liquor to wood by weight	*Spent liquor recovered, %*	*Theoretical total solids content of spent liquor, %*
3	25	15.7
3	50	21.9
3	75	26.0
3	85	48.2
4	25	11.8
4	50	17.2
4	75	29.4
4	85	40.9
5	25	9.9
5	50	14.2
5	75	24.8
5	85	36.3
6	25	8.3
6	50	12.1
6	75	21.5
6	85	31.2

[a] Based on pulp yield of 75% and total chemical consumption of 15% of the wood.

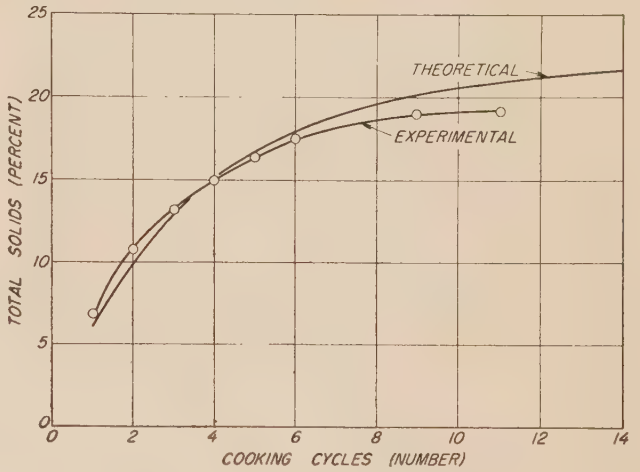

Fig. 1. Relations between total solids in semichemical spent liquor and number of cooking cycles

$$T_n = \frac{(1 - x^n)(1 - y)(I + P) - (1 - x^{n-1})zP}{(1 - x)W + (1 - x^n)(1 - y)(I + P) - (1 - x^{n-1})zP} \times 100$$

where

T = total solids content of spent liquor (in per cent)
n = number of cycles of digestions
I = inorganic chemicals for cooking (in per cent of wood)
P = 100 − yield (in per cent)
W = water in system (in per cent of wood)
x = fraction of total volume of liquor reused
y = fraction of total solids retained in chips not in spent liquor
z = fraction of organic solids precipitated on standing

The maximum value at equilibrium and intermediate values were calculated for the experimental conditions above, assuming 10% losses of solid matter from precipitation and held within the chips. The theoretical relation for the given conditions is shown graphically in Fig. 1 together with the experimentally determined relation. The theoretical maximum total solids value

Table II. Properties of the Cooking Liquors and Pulp Yields

		Cooking liquor charged						*Free spent liquor*			*Combined spent and pressed liquors*						
Cycle no.	*Digestion nos.*	*Na_2SO_3, g./l.*	*Na-HCO_3, g./l.*	*pH*	*Specific gravity*	*Total solids, g./l.*	*Inorganic solids as Na_2SO_4, g./l.*	*Na_2SO_3, g./l.*	*Specific gravity*	*pH*	*Na_2SO_3, g./l.*	*Na-HCO_3, g./l.*	*Specific gravity*	*pH*	*Total solids, g./l.*	*Inorganic solids as Na_2SO_4, g./l.*	*Yield, moisture-free basis, %*
1	689y 695y 701y	36.5	18.9	8.4	1.048	54	59	9.8	1.043	7.2	8.7	3.9	1.045	7.5	76	44	73.8
2	690y 702y	36.2	18.6	8.2	1.074	104	83	9.1	1.062	7.3	8.3	4.1	1.062	7.8	114	62	75.0
3	691y 703y	36.2	18.7	8.2	1.087	141	101	8.7	1.078	7.6	8.3	4.1	1.076	8.0	143	76	75.2
4	692y 704y	35.4	20.5	8.3	1.103	171	115	8.3	1.085	7.7	8.0	5.3	1.085	8.1	162	86	75.4
5	693y	36.6	18.7	8.4	1.111	189	123	8.5	1.092	7.9	8.2	5.5	1.092	8.1	178	96	75.6
6	694y	36.9	19.1	8.4	1.119	212	134	8.1	1.097	7.8	8.7	6.3	1.097	8.1	191	102	75.4
7	696y	36.7	18.9	8.4	1.127	220	141	8.5	1.102	7.7	9.0	6.4	1.102	8.1	...	...	75.6
8	697y	37.3	18.9	8.3	1.130	229	147	8.9	1.104	7.8	9.0	5.6	...	8.2	...	...	75.2
9	698y	36.6	18.3	8.4	1.135	245	152	8.0	1.109	7.7	8.2	5.5	1.108	8.1	211	113	76.2
10	699y	36.6	18.6	8.4	1.138	244	156	8.7	1.109	8.2	8.3	6.2	...	8.1	213	115	76.5
11	700y	36.6	18.5	8.4	1.138	244	156	9.1	1.109	8.0	8.5	6.3	1.110	8.2	212	114	75.9

was 22.5%, and 90% of this value was reached after nine cycles. The fact that the experimental total solids values are lower than the theoretical values after six cycles can be explained by the increase in amounts of precipitate and reaction products in the undefibered chips with repeated reuse of the spent liquor.

Theoretical maximum values of the total solids content of the spent liquor for various ratios of liquor to wood and proportions of total solids recovered are given in Table I to illustrate the limits to be expected under various operating situations. These values are based on the assumption that the solids are completely soluble and uniformly distributed in the spent liquor.

The maximum total solids content and the number of cycles to reach a finite proportion of this maximum will be affected by the chemical composition and density of the wood. Different woods require different amounts of cooking chemical to reach a given yield or a given lignin content in the pulp. The greater the amount of chemical used the higher the maximum viscous with continued recycling. The changes were small, however, within the limit of the present experiments. The viscosity of the liquor would be expected to be directly dependent on temperature.

A small increase in the pH index of the spent liquor resulted from recycling. This may have been due to the buffering effect of the large amount of organic material present. It would mean practically that the content of sodium bicarbonate in the cooking liquor could be reduced after a few cycles of digestions.

The yellow precipitate from the spent liquor was indicated by a qualitative test with B-naphthylamine to be largely a ligneous material.

Pulp Yield

The yield of pulp increased slightly (from approximately 74 to 76%) in the course of the recycling of the spent liquor (Table II). However, the yield appeared to have reached a maximum value after the ninth cycle of cooking, or at about the point where the total solids content of the spent liquor had very nearly

Table III. Chemical Composition and Strength Properties of the Pulps[a]

		Chemical constituents						Strength properties, 25 × 40—500 ream									
									Bursting strength		Tearing strength		Breaking length		Double folds		Density
Cycle no.	Digestion nos.	Lignin, %	Holocellulose, %	Alphacellulose, %	Pentosans, %	Hot water solubility, %	Ash, %	Brightness, parts blue[b]	500 ml. freeness, pt./lb./ream	250 ml. freeness, pt./lb./ream	500 ml. freeness, g./lb./ream	250 ml. freeness, g./lb./ream	500 ml. freeness, meters	250 ml. freeness, meters	500 ml. freeness, M.I.T.	250 ml. freeness, M.I.T.	500 ml. freeness, g./cc.	250 ml. freeness, g./cc.
1	689y 695y 701y	10.1	84.3	63.8	17.9	2.5	1.3	51.2	0.57	0.84	0.99	0.83	4600	7000	80	500	0.62	0.73
2	690y 702y	10.4	83.3	63.2	18.6	2.3	1.4	50.7	0.59	0.88	0.87	0.72	5300	6800	80	530	0.62	0.74
3	691y 703y	10.3	84.4	63.0	19.0	2.8	1.3	49.9	0.56	0.84	0.90	0.75	4800	7000	60	400	0.63	0.74
4	692y 704y	...	...	...	...	...	...	48.4	0.59	0.83	0.89	0.76	5100	7200	75	400	0.63	0.76
5	693y	...	...	...	...	...	...	49.1	0.58	0.87	1.00	0.83	4700	7000	70	380	0.60	0.72
6	694y	...	...	...	...	...	...	48.2	0.54	0.84	0.95	0.70	4300	6800	80	630	0.62	0.74
7	696y	...	...	...	...	...	...	48.0	...	...	...	...	...	...	...	...	...	...
8	697y	...	...	...	...	...	...	49.2	0.68	0.90	0.94	0.75	4900	7200	125	625	0.64	0.77
9	698y	11.2	83.2	62.5	...	3.0	1.2	48.4	0.52	0.81	0.90	0.70	4800	6900	25	400	0.62	0.76
10	699y	11.4	83.8	61.4	19.0	2.8	1.2	...	0.54	0.86	1.05	0.74	4700	7000	80	425	0.59	0.74
11	700y	10.3	83.6	61.5	18.9	3.3	1.2	46.7	0.54	0.83	0.98	0.76	5200	6900	65	425	0.63	0.76

[a] All percentages are on a moisture-free weight basis.
[b] G.E. as read on Hunter reflectometer.

total solids content will be. The amount of free-draining liquor will increase with increasing density because of the decreasing amount of void space within the wood available to hold the spent liquor. Birch chips, for example, will hold only about 55% of the amount of spent liquor that will be held in aspen chips when compared on the basis of the same semichemical pulp weight. This means that practical equilibrium will be reached later with dense woods than with light woods, other conditions being the same.

Since the dissolved solids are recirculated it is obvious that, as equilibrium conditions are approached, the cooked chips and unrecovered spent liquor from each digestion will carry to the refiners and washers the equivalent of all the waste products from that digestion.

The total solids content of the spent liquor closely approached a maximum or equilibrium value of about 19% (212 grams per liter) after 10 digestions, and reached 90% of that value after six cycles (Table II and Fig. 1). The spent liquor and the cooking liquor after fortification became increasingly more sticky and reached its maximum. The increase in yield may have been due to (1) the reaction of small amounts of cooking chemical with organic products in the reused spent liquor and so reducing the amount expended in pulping the wood, and (2) lower amounts of sodium sulphite in the cooking liquor than indicated by the analysis. Such might be the result if the large amounts of organic matter present affected the iodine test for the sodium sulphite. In a continuous recycling operation over a long period the actual amount of fresh make-up chemical used would indicate whether the test method was in error.

Pulp Properties

The chemical composition of the pulps varied slightly with recycling of the spent liquor (Table III). There were trends toward a small increase in lignin content and a small decrease in alpha-cellulose content. (These trends were in line with the trend of small increase in pulp yield.) The increase in lignin content would possibly be sufficient to require an adjustment in the

cooking conditions if bleachable pulps were being made.

Pulp brightness decreased (approximately 4 percentage points) with recycling of the spent liquor (Table III). This decrease may have been related to the increase in the pH index of the spent liquor (Table II). The reduction in brightness would not be expected to affect either the use of the pulp in the unbleached state or its conversion to a bleached pulp.

Pulp strength was not affected by recycling the spent liquor within the limit of these experiments (Table III).

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The Microscopic Identification of Paper Fillers

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The identification of the more common paper fillers with the aid of a microscope is discussed. The methods of chemical microscopy applied are recommended as being fast, convenient, and dependable. Procedures are given for the recognition of diatomaceous earth, talc, clay, and the ions of calcium, zinc, barium, and titanium. Fourteen photomicrographs are included.

The qualitative analysis of papers for mineral fillers is done readily and quickly with the aid of a microscope. The methods of chemical microscopy afford many advantages over the more commonly used and more familiar macro methods, and yet to learn to use them effectively requires no more study than, for example, a series of specialized qualitative analytical procedures. Practically all paper mill laboratories are now equipped with microscopes, and the laboratory personnel use them regularly for fiber identification, speck and dirt analysis, and in many other ways. The application of these instruments and the accompanying technique to still another problem affords no difficulties. The methods of chemical microscopy are not only faster and more convenient than the macro-qualitative methods, but they offer other advantages as well. Comparatively speaking, only very small samples are required. The ash resulting from a regular ash determination is more than ample, and where the sample of paper is limited, a much smaller ash sample is sufficient. Tests for the presence of any one constituent can be made without preparatory separations. In many cases, the actual chemical compounds are recognized instantly, and it is unnecessary to assume a theoretical combination of the ions. Moreover, microscopic analyses afford immediate information as to the particle size and shape of the fillers which cannot be determined in any other way. The procedures described here are those that have been in use in our laboratories for many years, and they have been found to give dependable results. During this time many people having no previous training in the use of the microscope have learned the technique by examining the ashes from papers of known filler content. In the following discussion, procedures are given for the recognition of diatomaceous earth, talc, clay, calcium sulphate, calcium carbonate, and compounds containing the ions of calcium, zinc, barium, and titanium. Other less common mineral fillers may be detected by variations of these procedures or by other chemical and optical tests found in the literature cited later.

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EQUIPMENT AND MATERIALS

The ordinary paper mill compound microscope is satisfactory. More elaborate instruments with polarizers and analyzers are not essential for the procedures given here but will give valuable information in special instances. The solutions should, for convenience, be in small bottles with droppers; and the solid chemicals should be in small bottles with glass stoppers. The water referred to is, in each case, distilled water. The exact concentration of the dilute acids is not important, but a concentration of 4 parts water to 1 part acid is convenient. Since the quantities used are small, thin glass rods or glass rods drawn out to tapered ends are useful. For much of the work, a magnification between 40 and 100 diameters is preferable, but occasionally a magnification of 200 to 300 diameters is used.

DIATOMACEOUS EARTHS, TALC, AND CLAY

Diatomaceous earth, talc, and clay can usually be recognized by the appearance and size of the particles. For this examination, a dispersion of the material is prepared on a microscope slide. A small amount of the ash is transferred to a drop of water on the slide and covered with a cover glass, which is then moved around with gradually increased pressure to separate the particles.

The diatomaceous earths are the fossil remains of microscopic plants. Chemically, they are nearly pure silica. They are recognized by their characteristic shapes and symmetrical markings. Although many shapes and forms are found, the material is readily identified. The rods and honeycomblike sections are often the first particles to be recognized in an unknown specimen at low magnification, Fig. 1. Higher magnifications may be necessary to show the details of some of the more intricate designs, as shown in Figs. 2 and 3.

Usually, talc particles are larger than either the diatomaceous earth or the clay particles, and the sharp

outlines of a large proportion of the particles can be observed under low magnification. The talc particles are irregular in outline and the so-called fibrous talcs are

Fig. 1. Diatomaceous earth. 75×

longer in one dimension. A talc, similar to the talcs used in most papers, is shown in Figs. 4 and 5, which are photomicrographs of a sample at low and high magnifications, respectively. Figure 6, a photomicrograph at low magnification, illustrates one of the fibrous agalite talcs.

If the majority of the particles on the slide are very small, usually too small to be resolved at low power,

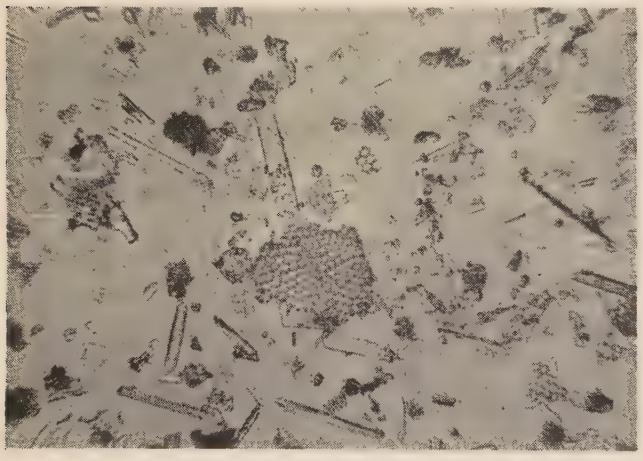

Fig. 2. Diatomaceous earth. 400×

either clay or a chemically precipitated filler is indicated. The particles of natural fillers are irregular and not uniform in size; the particles of precipitated fillers are more regular, more uniform, and usually much finer. Clay is identified by the presence of characteristic flat plates of kaolinite and mica which are comparatively large. Slowly raising the microscope tube slightly out of focus will cause some of these plates to stand out as bright areas in the field and so help in locating them. The outlines of the small particles of clay, which comprise the bulk of the material, can be brought out only at higher magnifications. Figure 7 is a photomicrograph of a clay at low magnification, and Fig. 8 is the same at high magnification. These show the characteristic flat plates and the fineness of the small particles.

CALCIUM COMPOUNDS

The presence of calcium compounds is recognized by the formation of characteristic crystals of calcium sul-

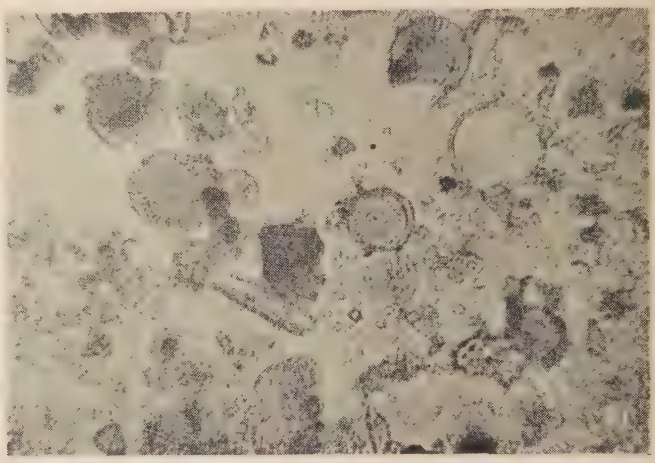

Fig. 3. Diatomaceous earth. 400×

phate or of calcium iodate. The more common calcium compounds used as paper fillers are calcium carbonate and calcium sulphate, and the tests described here will differentiate between these and will also show the presence of calcium ions.

The following tests involve the addition of acids as the first steps in preparing the slides and any effervescence at this point will indicate the presence of a car-

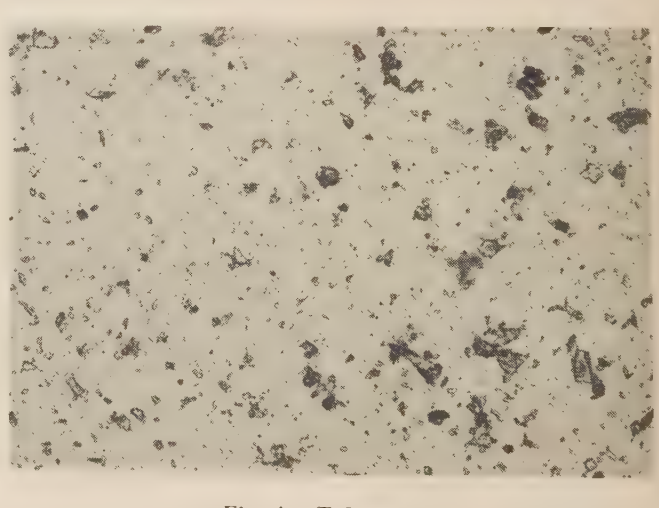

Fig. 4. Talc. 75×

bonate. Often, however, the carbonate is destroyed when the paper is ashed. In this case, the ash will give a strongly alkaline reaction with phenolphthalein.

To test the ash by the formation of calcium sulphate crystals, a drop of dilute hydrochloric acid is placed on one corner of a slide and a small quantity of the sample is added to it. The drop is evaporated to complete dryness by holding the corner of the slide above a microburner flame. In this operation, the slide is held slightly inclined down toward the drop, and the heat is applied near the top edge of the drop to prevent it from spreading upward across the slide. A drop of water is then added to the cooled residue, and, if the

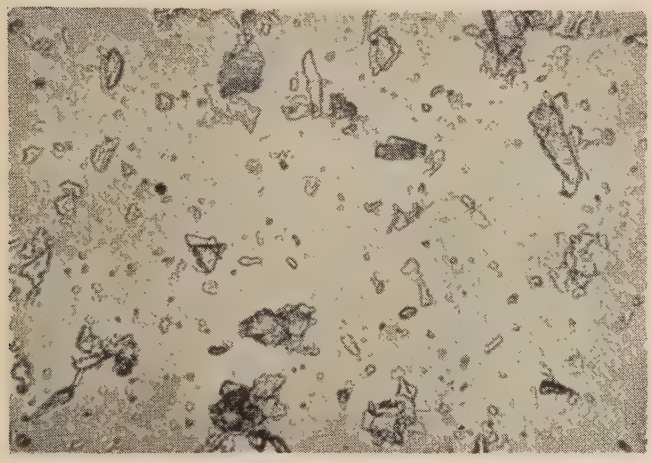

Fig. 5. Talc. 400×

sample contained calcium sulphate added as filler, individual and radiating clusters of needlelike crystals will form. If the concentration of calcium sulphate happens to be low, warming the solution will hasten the crystallization. The edges of the drop are examined first, since it is there that the crystallization will start. These crystals grow rapidly and, as they do so, some of the needles will be seen to grow in width and

Fig. 6. Fibrous agalite talc. 75×

finally form overlapping arrow tail formations. These are positive identification of calcium. See Fig. 9, which is a photomicrograph of calcium sulphate at low power magnification. A group of arrow tails appear near one corner of the field. Figures 10 and 11 are photomicrographs at high magnification showing masses

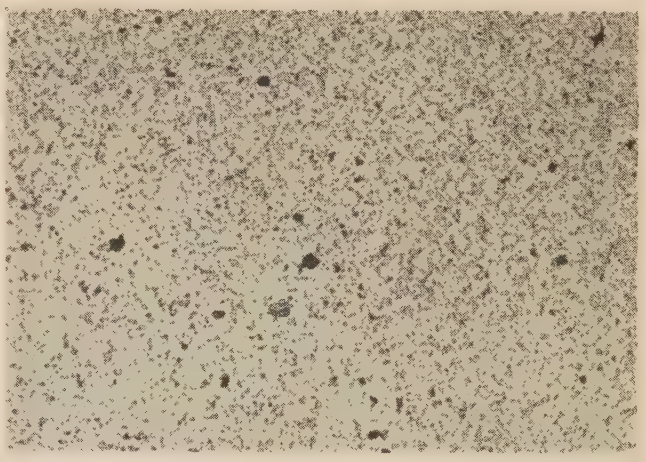

Fig. 7. Clay. 75×

of needlelike crystals with arrow tails fully formed, and several others forming. If the characteristic crystals do not form, prepare a new slide and add dilute sulphuric acid directly to the evaporated residue. If the characteristic crystals form in the presence of added sulphuric acid, the presence of the calcium ion is indicated.

To determine the presence of calcium ions by the

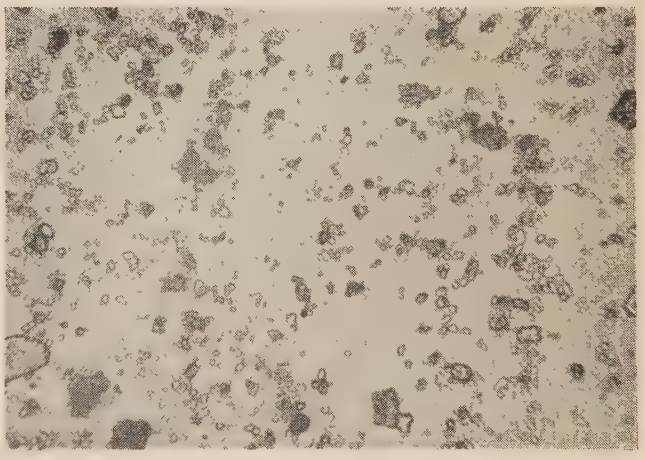

Fig. 8. Clay. 400×

iodate method, a small amount of ash is mixed with a drop of water on a slide and to this a small quantity of iodic acid is added. The iodic acid is dissolved in a separate drop of water, which is caused to flow into the sample by drawing a glass rod from the one drop into the other accompanied by a slight tilt of the slide. The calcium iodate forms as distinctive, colorless, diamond-shaped crystals, Fig. 12. It may be necessary to start crystallization by scratching the slide lightly with a glass rod, as the calcium iodate tends to form

supersaturated solutions. At times, the crystals form slowly. The slide should, therefore, be laid aside and examined again from time to time while other slides are being prepared.

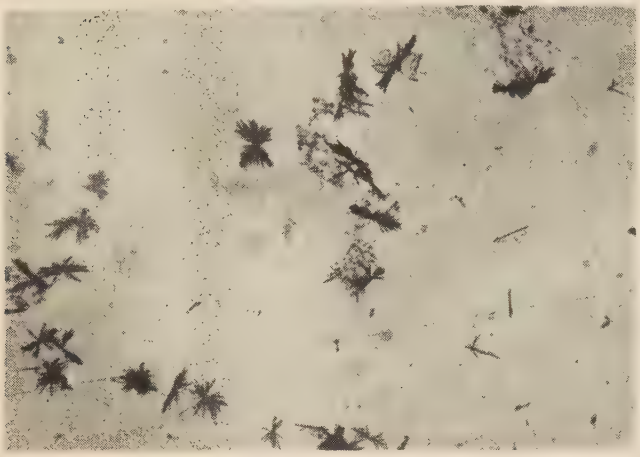

Fig. 9. Recrystallized calcium sulphate. 75×

If the analyst is careful to use only a small quantity of the solid iodic acid, it may be dissolved directly in the drop of water containing the unknown. A short cut used by experienced analysts is to add solid iodic acid to the original suspension prepared for examination for diatomaceous earth, talc, and clay. This procedure serves a threefold purpose. The iodic acid immediately

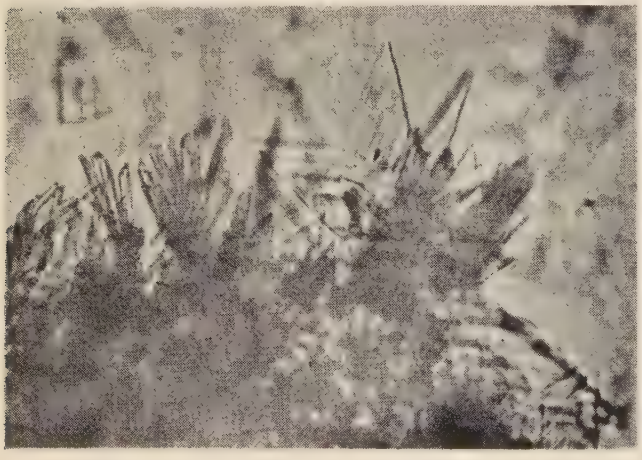

Fig. 10. Recrystallized calcium sulphate showing arrow tails forming. 400×

indicates the presence of carbonates by causing them to effervesce; it aids in dispersing the filler particles, and it reacts to confirm the presence of calcium if this ion is present.

ZINC COMPOUNDS

The presence of zinc is confirmed by the formation of characteristic crystals of zinc mercuric thiocyanate. To put the zinc compounds into solution and to avoid the possible interference by strong acids, the sample is repeatedly evaporated to dryness with nitric acid. To do this, a small quantity of ash is added to a drop of dilute nitric acid on one corner of a slide, and this is then evaporated to complete dryness using the procedure described earlier. When the residue is dry and cool, a second drop of nitric acid is added and again evaporated. This is repeated a third time. A drop of water is then added and slightly acidified with acetic acid. Stirring the water drop with a thin glass rod only moist with acetic acid gives good results. Allow-

Fig. 11. Recrystallized calcium sulphate showing arrow tails fully formed. 400×

ing a drop of acetic acid to run down the bottom inch or so of the rod and shaking off any free drops gives the right amount to use.

In a second small drop of water on the slide dissolve some potassium mercuric thiocyanate. Use several times as much of this reagent as was used of the ash. The reagent drop is then caused to flow into the un-

Fig. 12. Calcium iodate crystals. 75×

known. If zinc is present, colorless crystals in the shape of feathery crosses are formed (see Fig. 13).

These crystals appear black by transmitted light but

appear white on a black background by reflected light. If numerous prisms and square tablets are obtained, the test should be repeated with more attention being paid to the completeness of the evaporations, to the concentration of acetic acid, and to the concentrations of the unknown and reagent solutions.

BARIUM COMPOUNDS

The test to confirm the presence of barium compounds depends on the formation of characteristic barium sulphate crystals by recrystallization from sulphuric acid. A very small quantity of unknown is added to a generous drop of dilute sulphuric acid on one corner of a slide and this is concentrated by heating over the burner until strong white fumes appear. The analyst is cautioned against heating the slide too rapidly. When the slide is partly cool, breathe on the slide a few times to start recrystallization. If barium is present, it is evidenced by the formation of barium sulphate crystals which appear as feathery crosses with a marked tendency for two of the adjacent arms to be longer than the other two (see Fig. 14). These crystals may develop slowly and considerable time should be allowed for their appearance.

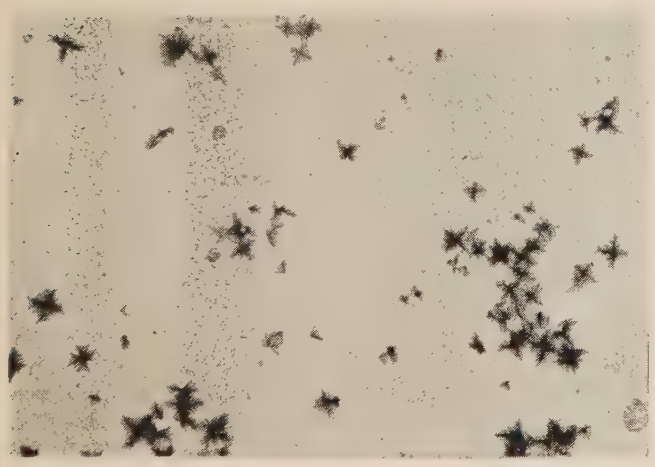

Fig. 13. Zinc mercuric thiocyanate crystals. 75×

This procedure also provides another indication of the presence of calcium. From the concentrated acid, calcium sulphate recrystallizes as very small rounded grains with short hairlike projections on either end.

TITANIUM COMPOUNDS

The experienced analyst will learn to suspect the presence of titanium dioxide from the appearance of the sample when it is examined under the microscope for clay or talc. Under transmitted light, titanium dioxide appears as minute pitch-black particles.

The confirming test for titanium is an adaptation of the qualitative color reaction. The microscope is not used for this test. A fairly large quantity of the unknown is placed in a drop of dilute sulphuric acid on one corner of a slide. Solid ammonium sulphate is then added and the drop is slowly evaporated over the flame of the burner until strong white fumes have appeared for several seconds. After the drop has cooled, sufficient water is added to bring it back to approximately its original volume. Upon adding 3% hydrogen peroxide to the drop on the slide, the characteristic yellow-to-orange color will appear if titanium is present.

If a large amount of the unknown was used and the yellow color developed is very weak, the test should be repeated with a lesser quantity of the unknown and a comparison should be made with a known sample of clay. Some clays have sufficient titanium present to show by this test when a large sample is used. Varying the quantity of sample will, however, distinguish between the titanium naturally in the clay and that which has been added as filler.

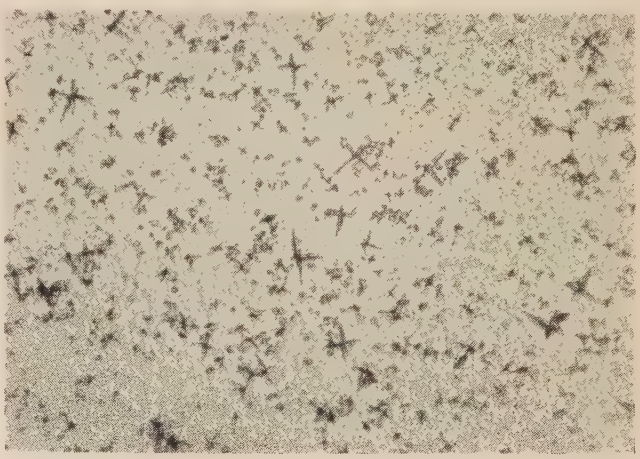

Fig. 14. Recrystallized barium sulphate. 75×

ADDITIONAL INFORMATION

Valuable additional information is to be found in the literature and in the books on the general subjects of chemical microscopy, crystallography, and petrography. Some years ago, Geohegan (*1*, *2*) outlined the analysis of paper fillers and included a description of their optical properties. More recently, Armitage (*3*) discussed a number of uses for a microscope in a paper mill and included among them its use for the identification of fillers. Observations of the optical properties of the fillers such as their indices of refraction, birefringence, extinction angles, and interference figures can be used to confirm their identity and to identify the crystals formed in the test reactions. The books on chemical microscopy by Chamot and Mason (*4*) are very valuable sources of information on the uses of microscopes, the techniques of chemical microscopy, and the detection of the elements.

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Peroxide Bleaching of Groundwood and Sulphite Pulps

RICHARD A. PREMO

Modernization of the Gould Paper Co. mill and the conversion of this mill from the manufacture of newsprint to the production of higher grade papers was completed early in 1950. For the manufacture of the new line of paper products facilities were required for bleaching groundwood and sulphite pulp. Since peroxide bleaching was known to be applicable for bleaching both pulps to the desired brightness, a new peroxide bleachery was designed and installed for bleaching groundwood and sulphite pulps, either separately or in mixtures. This modern peroxide bleachery is operating at a consistency of 12 to 15% with a capacity for bleaching 100 tons of groundwood, or 130 tons of groundwood-sulphite mixtures, or 130 tons of sulphite pulp per day. With 2% sodium peroxide brightnesses of 70 to 71 are obtained on groundwood alone and on mixtures of groundwood and sulphite pulp, while on sulphite pulp the bleached brightness is approximately 75. Percentages of groundwood and sulphite pulp in the mixture are controlled at will for the production of a range of papers including high-grade printing papers and allied grades. Automatic equipment for the continuous preparation of the peroxide bleaching solution, a novel feature in this bleachery, has been giving good performance in day-by-day operation. Plans for the bleachery were well considered. Careful attention was given to essential details in the choice of proper equipment and in the bleachery layout for ease of operation. The performance of the bleachery has been excellent from the start about a year ago.

Prior to the recent modernization of the Gould Paper Co. mill, the groundwood and sulphite pulp produced at Lyons Falls were used for the manufacture of newsprint and allied grades of paper. Conversion from newsprint to higher grades of printing papers required facilities for bleaching both types of pulp. Since both groundwood and sulphite pulp were known to react favorably to peroxide bleaching and since these pulps, after peroxide bleaching, were known to have desirable characteristics and properties for the manufacture of higher grade printing papers, a peroxide bleachery was included in the modernization plans.

Construction of a peroxide bleachery with a capacity of 100 to 130 tons per day at 12 to 15% consistency was started in the fall of 1949 and was put into operation in March, 1950. The bleachery has been operated with different ratios of groundwood and sulphite pulp, as well as on 100% sulphite pulp.

Both low consistency (4 to 6%) and medium consistency (10 to 15%) peroxide bleaching systems for bleaching groundwood, as well as a hypochlorite bleachery for sulphite pulp, received due consideration. The following factors influenced the decision to install a medium consistency peroxide bleachery: (1) high pulp yields, (2) adequate pulp brightness, (3) good papermaking pulp quality, (4) small space requirements, and (5) ability to bleach both groundwood and sulphite pulp in one bleachery.

The bleachery was designed and constructed by the engineering and construction departments of Gould Paper Co., in cooperation with the Ansul Chemical Co., the Brown Instrument Co., the Electrochemicals Department of E. I. du Pont de Nemours and Co., Inc., the Fischer and Porter Co., the General Electric Co., the Improved Paper Machinery Corp., the Stebbins Engineering and Manufacturing Co., the Virginia Smelting Co., and Proportioneers, Inc.

The bleachery is located in a section of the building in which the steam power plant was formerly located. The new power plant, built a short distance from the bleachery, is a part of the extensive modernization program at this mill.

In basic design the new medium consistency peroxide bleachery is essentially similar to several other bleacheries of its kind operating in the United States. New features include the automatic preparation of the bleaching solution and the centralized control for ease of operation.

AUTOMATIC PREPARATION OF THE PEROXIDE BLEACHING SOLUTION

The continuous process for the preparation of the peroxide bleaching solution has advantages over the batch process: (1) ease of operation, (2) elimination of active oxygen losses which may be incurred during long-time storage in the batch process, particularly when the temperature of the make-up water is high, and (3) simplicity and speed in changing the bleaching formula when shifting from one furnish to another.

This system (see Fig. 1) consists of a stainless steel mixing tank divided into four compartments. Each separating wall has a V notch weir at the proper level to provide for an overflow into the next compartment.

In the continuous system for preparing the peroxide bleaching solution the water is metered at the desired rate into the first compartment. An orifice permits a portion of the water to flow through a mixing chamber in the bottom of an Omega Epsom salt feeder. The Epsom salt drops from the tray of the feeder into the water and is dissolved by the swirling motion of the water in the mixing chamber. The swirling motion of the water is obtained by the tangentially located water inlet pipe. The Epsom salt solution overflows from the chamber and passes into the first compartment. A conductivity cell is installed in the line to serve as an alarm in the event no Epsom salt solution is being fed. Sodium silicate is pumped to the first compartment of the mixing tank by a proportioning pump where the Epsom salt and the sodium silicate are thoroughly mixed with the water by a propeller-type agitator.

After the first compartment of the mixing tank is filled with the solution containing sodium silicate,

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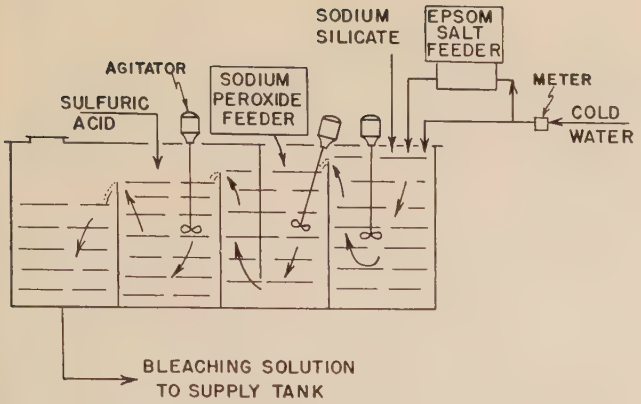

Fig. 1. Continuous preparation of the bleaching solution

Epsom salt, and water, the solution continually overflows to the second compartment where sodium peroxide is added at a definite rate by an Omega loss-in-weight gravimetric feeder. This feeder is equipped with a hopper of sufficient capacity to hold 2000 pounds of sodium peroxide. An agitator and baffle are included in this compartment to assure proper dissolving of the sodium peroxide and to prevent short circuiting of the mixture to the third compartment.

The solution, now containing Epsom salt, sodium silicate, and sodium peroxide, overflows into the third agitated compartment where sulphuric acid is fed in at a controlled rate by a mercury fluid plunger-type proportioning pump. The prepared bleaching solution overflows into the fourth compartment which serves as a sampling compartment. From the fourth compartment the bleaching solution flows by gravity into a tile storage tank equipped with a bubble-type level control. This level control, set to maintain a 2 to 3 foot depth of bleaching solution in the storage tank (approximately 950 gallons), starts the bleaching solution preparation equipment when the level drops below the desired point in the storage tank and stops the preparation equipment when the level rises above the desired point.

The peroxide bleaching solution is transferred to the bleaching process by a proportioning pump equipped with a d.c. motor and G.E. Thymatrol control to permit variation in the rate of bleaching solution fed to the bleaching process.

Following is a typical formula for bleaching mixtures of groundwood and sulphite pulp with 2% sodium peroxide, based on the moisture-free weight of the pulp:

Epsom salt	0.05%	1.0 lb./ton
Sodium silicate	5.0%	100 lb./ton
Sodium peroxide	2.0%	40 lb./ton
Sulphuric acid	1.6%	32 lb./ton

This formula is satisfactory for a sulphite pulp content in the mixture of 50% or less. For higher percentages of sulphite pulp the alkalinity of the formula is decreased by increasing the amount of acid used. When bleaching 100% sulphite pulp, 0.5% sulphuric acid in the bleaching formula with 2% sodium peroxide has given best results.

BLEACHING EQUIPMENT

Figure 2 shows a simplified flow diagram of the medium consistency peroxide bleaching installation. The unbleached groundwood and sulphite pulp are pumped from their respective storage chests to separate pulp meters equipped with a consistency regulator. Metered quantities of groundwood and sulphite pulp at approximately 3% moisture-free consistency, drop by gravity into a vacuum seal box and are lifted by a fan pump at approximately 1.5% consistency to the thickener vat on the top level of the bleachery. An 8-foot diameter by 16-foot long IMPCO vacuum thickener with a press roll is used to dewater the pulp to a consistency of 12 to 15%. White water from the thickener goes to a separator of the Nash vacuum pump system which separates air and water. It then drops by gravity to the seal box where part of it is used to dilute the incoming stock from the groundwood and sulphite meters, and the remainder is returned to the groundwood mill. The sheet of thickened pulp mixture discharged from the thickener is shredded by a shredder roll located ahead of the high-speed, rubber-covered, vaned roll for pulp removal and then drops into a conveyor which collects the pulp from across the discharge face of the thickener. The pulp then drops into an IMPCO single-shaft mixer where it is mixed with steam to obtain a pulp mixture temperature of approximately 110°F. From the single-shaft mixer the heated pulp passes into an IMPCO double-shaft mixer. The peroxide bleaching solution enters the process at this point and is well mixed with the pulp mixture in passing through the double-shaft mixer. From here the pulp drops by gravity into the top of the retention tower 14 feet in diameter by 23 feet high. The feed of pulp to the top of the tower and the removal of the pulp by the IMPCO scraper and metering-type discharge screws at the bottom of the tower are controlled to retain the pulp in the tower 2 to 3 hours. From the bottom of the tower, the bleached pulp mixture drops into the neutralization chest. At this point the pH of the stock is 9.0 to 9.5, with a residual peroxide of about 10%.

In this chest the pulp is controlled to approximately 5% moisture-free consistency and neutralized with sulphur dioxide to eliminate the residual peroxide and alkali in the pulp and to reduce the pH of the pulp. From this chest the neutralized and bleached groundwood-sulphite pulp mixture passes to the agitated bleached stock storage chest.

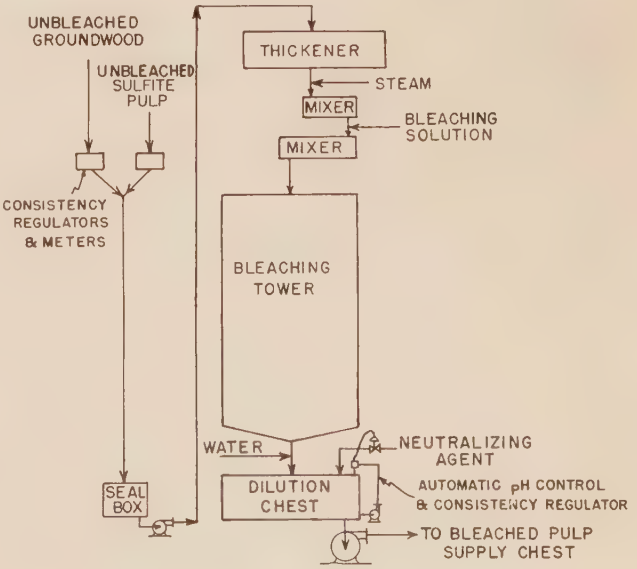

Fig 2. Peroxide bleaching equipment

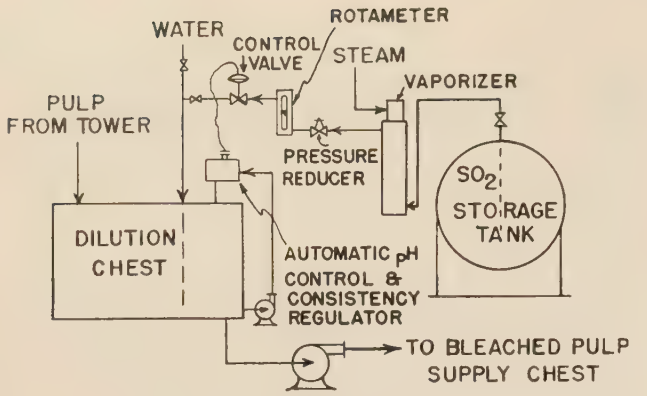

Fig. 3. Neutralization system

Each piece of equipment in the bleaching process is electrically interlocked with every other one so that interruption of any part of the process automatically shuts down the whole system.

Figure 3 shows the system used to handle the sulphur dioxide. In this system liquid sulphur dioxide flows to a steam vaporizer and the vaporized sulphur dioxide is metered through a Fischer and Porter rotameter and mixed with water in a special mixing tee, the mixture flowing to the neutralization chest. The sulphur flow is controlled by a diaphragm valve actuated by pH electrodes located in the bleached pulp consistency regulator. In this step sufficient sulphur dioxide is used to reduce the pH to 6.5 to 7 which is ample to eliminate any residual peroxide.

CONTROL OF THE BLEACHING PROCESS

Centralized control of the bleaching process is made possible by proper location of the bleaching equipment and the control instruments. The bleaching equipment was installed in a relatively small area and the control panel is centrally located for convenient control of the bleaching operations. Routine laboratory control tests are carried out in the same area.

The control board for the process includes instruments for indicating, recording, and controlling the bleaching rate, the bleaching temperature at the top and the bottom of the tower, the feed rate of the bleaching solution, the pulp level in tower, the pH of the bleached and neutralized pulp, the pulp level in bleached stock storage chest, the level of the bleaching solution in the storage tank, the level of the stock in the thickener vat, the level of the stock in the neutralization chest, the speed of the metering screw conveyor, and the control of the equipment for preparing the bleaching solution.

The laboratory is equipped for routine control tests on the bleaching solution and on the residual peroxide and alkali in the pulp at the top and bottom of the tower. Hourly tests are made and recorded on a control sheet which includes standards of operation for the guidance of the operators.

CHEMICAL STORAGE

Sodium peroxide, sodium silicate, Epsom salt, sulphuric acid, and sulphur dioxide are the chemicals used in the operation.

The sodium peroxide is received in steel drums containing 400 pounds net. This chemical is stored in a separate fireproof room in the bleachery. For filling the hopper of the Omega feeder the drums are handled by a drum sling and monorail crane.

The sodium silicate is received in tank cars and transferred to a 15,000-gallon steel storage tank from which it is metered by a proportioning pump to the bleaching solution preparation system.

Epsom salt is received in 100-pound paper bags and transferred to the hopper of the Omega feeder manually.

The sulphuric acid is received in tank cars and transferred to an 11,800-gallon steel storage tank from which the acid is transferred by a mercury-type metering pump to the bleaching solution preparation system.

Liquid sulphur dioxide is received in tank cars and unloaded into a steel storage tank with a capacity of 7500 gallons.

All railroad cars are spotted on a trestle alongside the bleachery and the storage tanks for acid, silicate, and sulphur dioxide are located at the lowest level in the bleach plant. This permits gravity unloading of the tank cars.

MATERIALS OF CONSTRUCTION

The materials of construction used in the peroxide bleachery are usual to pulp and paper mills including stainless steel, tile, transite, steel, and rubber-covered steel.

The peroxide bleaching solution preparation tanks, the head of the bleaching solution transfer pump, and the transfer lines are made of stainless steel, and the storage tank for the bleaching solution of tile. Stainless steel lines are used to transfer the bleaching solution to the double-shaft mixer.

Rubber covering is used on the steel parts of the vacuum thickener, and the vat is constructed of tile. The single-shaft mixer is fabricated of cast iron, and the double-shaft mixer is rubber-covered steel.

To permit operation of the bleachery at temperatures in excess of 120°F. a concrete tower with 2-inch tile lining was installed. The neutralization chest at the bottom of the tower is made of tile.

All lines handling bleached or unbleached stock are made of transite. The sulphur dioxide is handled in iron pipes up to the point where water is added, from which point it is handled in stainless steel pipes.

BLEACHING RESULTS

During initial operation of this bleachery groundwood alone was bleached. The groundwood with a brightness of 62.5 (Photovolt) was bleached to a brightness of 70.5 using 1.6% sodium peroxide. Groundwood in this mill is prepared from spruce wood.

Operating with 1.6% sodium peroxide on a mixture of 70% groundwood and 30% sulphite the brightness is raised from 60–62 to 68–71. Mixtures of 65% groundwood and 35% sulphite are bleached with 2% sodium peroxide to a brightness of 70 to 71 for a brightness gain of 10 to 11 points. The brightness of sulphite pulp is increased with 2% sodium peroxide from 55–59 to 73–75.

The ability to vary the percentage of groundwood and sulphite in the furnish to be bleached, to meet the particular requirements for a paper furnish, has proved to be a decided advantage.

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Compensating for Chip Moisture Variations by Chip Weighing

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This investigation relates to the weighing of pine chips at the digesters in the sulphate cooking process. Moisture tests were made on 190 experimental cooks in the 3000-cubic foot mill digesters. The weighing device substantiated the fact that with increasing chip moisture the chips are heavier and will pack more moisture-free wood per digester charge. It is shown how cooking tables may be designed with the aid of a weighing device so as to secure a close control of the ratio of alkali to moisture-free wood per digester charge. A discussion is shown of two methods of correcting for chip moisture variations: first, by maintaining a definite ratio of chip moisture to moisture-free wood; second, by maintaining a definite ratio of digester liquid volume (chip moisture, weak black and white liquor volume) to moisture-free wood.

One of the most important variables in the cooking process is the moisture content of the chips. Curran and Chidester (*1*) state: "wet chips tend to pack more and cook more slowly than dry chips and may sometimes add to the difficulty in maintaining the acid strength during warm weather." Sutermeister and Greep (*2*) state: "the moisture content of wood is of importance chiefly in connection with the necessary adjustment of the strength of the cooking liquor. If the final concentration of caustic soda, taking into account the water in the wood as well as that in the liquor itself, is kept constant, the same yield will be obtained, whether the chips contain 5 or 22% of moisture." Larcher and Thorsen (*3*) state: "with increased moisture, chips will weigh more and pack better in the digester. Thus the digester will hold more wood, dry weight, and the total active alkali will have to be increased to maintain the same quality of pulp. The harder packing of the wood will lessen the dead space between chips, and the larger quantity of water in the chips decreases the quantity of water that can be absorbed by them."

However, there is the problem of determining the chip moisture and the application of this information to mill operation. This investigation relates to the weighing of pine chips at the digesters in the sulphate cooking process and utilizing the weighing device to compensate for the effects of chip moisture variation in mill operation.

Chip storage is provided for in steel bins. From these bins, chips are discharged through chutes into a drag conveyor, transferred to a belt conveyor, which passes over the weighing device, to the digester loading floor. Loading of the digester is accomplished by means of a mechanical tripper. A remote counter, located on the digester loading floor, duplicates the master totalizing counter on the weighing device.

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DIGESTER LOADING PROCEDURE

Digesters are loaded by the following procedure: chips are run into the digester from the conveyor belt until 35,000 pounds of wet chips register on the weighing device remote counter; then the white liquor is started into the digester. As soon as 30 inches of white liquor register on the chart, the black liquor is started into the digester. When the digester becomes nearly full, a digester loader gives the cook the signal to stop the drag conveyor from the chip bins; the belt conveyor continues to travel and passes over the weighing device and to the digesters. This belt conveyor has just enough chips to fill the digester and the chip-tripper hopper. If the digester is not full on clearing the belt conveyor, a few more chips are transferred from the chip bins, and the digester loaded full. The chip-tripper hopper is cleared by rodding. Approximately 25 cubic feet of chips are rodded to clear the hopper. The white and black liquor are cut off just before the digester is full of chips. The final chip weight and cooking tables determine the final volume of white and black liquor to use from the measuring tanks.

DIGESTER CHIP CHARGE

Figure 1 shows the average curve taken from 190 experimental cooks in the 3000-cubic foot mill digesters. Wood storage varied from 7 months to very green as received on rail cars and trucks. Testing covered a period from Jan. 29, 1947, to Dec. 12, 1947. Moisture samples were taken while loading each digester. Approximately two thirds of a cubic foot of chips was taken, mixed thoroughly, and 1000 grams dried in oven at 105°C. for 24 hours. The moisture results were plotted against the recorded weight of the chip charge. Figure 1 shows that for a definite weight and volume (3000 cu. ft. of chips) there is a corresponding weight of moisture-free wood (A), weight of moisture (B), and percentage in chips (C). With increased chip moisture the chips are heavier and will pack more moisture-free chips per digester charge. This causes the ratio of moisture in the chip charge to the dry chip charge to increase. This increase in moisture may be compensated for by several methods which are discussed under liquor volume. Because of the increased dry wood per digester charge the alkali charge will have to be increased in order to secure the same quality of pulp for fixed cooking conditions.

Data taken from mill digester records show considerable variations in pounds of wet chips per digester charge. These variations, as shown in Table I, are caused by the following factors:

1. Weather conditions. The surface area of the stored wood is more exposed to the air and sunshine and will lose more moisture than the logs underneath.

Table I

Length of time wood stored	*Variations in digester charge, pounds of wet chips*
7 months	48,000–56,000
2–3 months	64,000–70,000
Green wood from rail cars and trucks	70,000–77,000

2. Lack of uniform chips. This depends upon the condition of the wood room equipment (chipper) and the dryness of the wood.

3. Length of time the chips are stored in the chip bins. The chips dry out in storage.

LIQUOR VOLUME

One of the most controversial subjects in the sulphate cooking process is liquor volume. It is recognized that sufficient liquor volume must be used for the digester contents to blow clear. Too much liquor volume results in liquor pull-over from the digester relief and interferes with the time cycle to temperature and pressure for fixed cooking schedule. It is also recognized that the more liquor volume that can be used without relief pull-over of liquor, the more uniform the pulp from top to bottom of the digester.

With these points in mind it is shown how the chip moisture variations may be corrected by two procedures: first by maintaining a definite ratio of chip moisture to moisture-free wood. Second by maintaining a definite ratio of digester liquid volume (chip moisture, white and weak black liquor volume) to moisture-free wood.

Computing a Definite Ratio of Chip Moisture to Moisture-Free Wood

Table II is a recast of Fig. 1 with additional data. In Table II the moisture was computed at each digester wet chip charge to cubic feet water and reported in column E. The cubic feet of water divided by 1000 pounds of moisture-free chips per digester charge will give column F, the ratio of cubic feet of moisture to 1000 pounds of moisture-free wood. This ratio at a digester wet chip charge of 50,000 pounds is 10.70; as the chip moisture increases this ratio increases, and at a digester wet chip charge of 80,000 pounds the ratio is 17.44.

It was desired to maintain a ratio of 15.93 cubic feet of chip moisture per 1000 pounds of moisture-free chips. Multiplying column C by 15.93 will give column G, the cubic feet moisture that the chips should have to maintain a definite ratio of moisture to moisture-free wood. Column E subtracted from column G will give

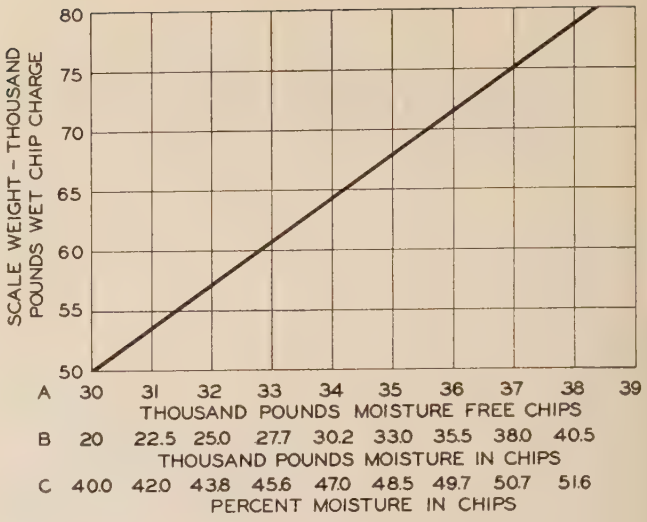
SCALE WEIGHT – THOUSAND POUNDS WET CHIP CHARGE
80
75
70
65
60
55
50
A 30 31 32 33 34 35 36 37 38 39
THOUSAND POUNDS MOISTURE FREE CHIPS
B 20 22.5 25.0 27.7 30.2 33.0 35.5 38.0 40.5
THOUSAND POUNDS MOISTURE IN CHIPS
C 40.0 42.0 43.8 45.6 47.0 48.5 49.7 50.7 51.6
PERCENT MOISTURE IN CHIPS

Fig. 1

column H, the cubic feet of moisture correction to be made up with weak black liquor. Column I is the inches of corrected weak black liquor from the measuring tank (9.32 cubic feet per inch). Column J is the addition of column I to a fixed 142 inches of white and weak black liquor volume at 72,000 pounds of wet chip digester charge. Column K is the white and weak black liquor converted to cubic feet. Column L is the total digester liquid volume (chip moisture, weak black and white liquor). Column M is the cubic feet of digester liquid volume per 100 pounds of moisture-free wood, which shows that this method does not give a definite ratio of digester liquid volume to moisture-free wood. However, this method compensates for the chip moisture in the sense that a definite ratio of chip moisture to moisture-free wood is maintained.

Computing a Definite Ratio of Digester Liquid Volume (Chip Moisture, Weak Black and White Liquor Volume) to Moisture-Free Wood

It was desired to maintain 52.576% of the moisture-free wood as the total digester liquid volume. Column C multiplied by 52.576% will give column N, the cubic feet total digester liquid volume. Subtracting the cubic feet of chip moisture, column E, from column N will give column O, the cubic feet of white and weak black liquor volume. Column P is the conversion of column O to inches of white and weak black liquor volume from the measuring tanks. Column R is the cubic feet digester liquid volume per 100 pounds of moisture-free chips. This method of computing moisture correction

Table II

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	R
Thousand lb. wet chips	*Moisture in chips, %*	*Thousand lb. m.-f. chips*	*Thousand lb. water in chips*	*Water in chips, cu. ft.*	*Moisture per 1000 lb. m.-f. chips, cu. ft.*	*Moisture based at 15.93 cu. ft. per 1000 lb. m.-f. chips, cu. ft.*	*Moisture correction to be made up with weak black liquor, cu. ft.*	*Weak black liquor moisture correction, in.*	*Black and white liquor volume, in.*	*Black and white liquor volume, cu. ft.*	*Total digester liquid volume, cu. ft.*	*Total liquid volume per 100 lb. m.-f. chips, cu. ft.*	*52.576% of m.-f. chips equals cu. ft. liquid volume*	*White and weak black liquor volume, cu. ft.*	*White and weak black liquor volume, in.*	*Total liquid volume per 100 lb. m.-f. chips, cu. ft.*
50	40.0	30.0	20.0	321	10.70	478	157	17	159	1482	1803	6.02	1577	1256	135	5.26
55	42.9	31.4	23.6	378	12.04	500	122	13	155	1445	1823	5.81	1651	1273	136	5.26
60	45.5	32.7	27.3	438	13.39	521	83	9	151	1407	1845	5.64	1719	1281	137	5.26
65	47.5	34.1	30.9	495	14.52	543	48	5	147	1370	1865	5.47	1793	1298	139	5.26
70	49.3	35.5	34.5	553	15.57	566	13	1	143	1333	1886	5.31	1866	1313	141	5.26
75	50.8	36.9	38.1	611	16.55	587	−24	−3	139	1295	1906	5.17	1940	1329	143	5.26
80	52.1	38.3	41.7	668	17.44	610	−58	−6	136	1268	1936	5.05	2014	1346	144	5.26

shows that a definite ratio of digester liquid volume to moisture-free wood can be obtained.

DESIGNING COOKING TABLES

From the results in Fig. 1 and Table II cooking tables were designed so as to maintain a close control of the ratio of chip moisture to moisture-free wood and provides a close control of the ratio of active alkali to moisture-free wood.

The cooking tables used in conjunction with the weighing device are composed of two separate charts. In the mill each chart is mounted in glass frames 18 by 21 inches with horizontal and vertical slides so as to read at the index.

Table III, titled "Corrected Cooking Tables," is composed of cooking tables 0 to 30. Each corrected cooking table corresponds to a definite number of pounds of active alkali as sodium hydroxide, the base charge being 5600 pounds of active alkali as NaOH at zero corrected cooking table and each successive table an increment of 75 pounds of alkali. The white cooking liquor is analyzed for active alkali (*4*) by titrating with 1.0 *N* hydrochloric acid. The milliliters of active alkali test and the corrected cooking table gives the inches of white liquor to use from the measuring tank. Tables III and IV are abbreviated to conserve space.

Table IV, titled "Specified Cooking Tables," is composed of Specified Cooking Tables 0 to 30. Each specified cooking table corresponds to a definite chemical treatment, the base treatment, being 15.4% at zero specified cooking table and each successive specified cooking table an increment of 0.2%. The chemical treatment is based on the moisture-free chips and the active alkali as NaOH. On the left vertical side of Table IV is the scale weight in thousands of pounds of wet chips. Applying the digester wet chip weight to Fig. 1, the moisture-free chips may be estimated. Therefore, the wet chip weight will represent definite amounts of moisture-free chips. The pounds of moisture-free chips multiplied by the chemical treatment, as shown horizontally at the bottom of Table IV, will give the pounds of active alkali to use for each scale wet chip weight. In order to simplify the chart, the pounds of alkali were changed over to corrected cooking tables by the substitution for the pounds of alkali the nearest corrected cooking table as shown horizontally on top of Table III. The corrected liquor volume, weak black and white liquor, is shown vertically on the left-hand side of Table IV.

Since the cooking tables will depend on the final scale chip weight, the amounts of liquors being charged by the automatic measuring instruments are stopped approximately 10 inches short of a full digester charge.

Table III

Active alkali test, ml.	*Corrected cooking tables* 9	10	11	12	13	14	15
	Pounds active alkali as NaOH 6275	6350	6425	6500	6575	6650	6725
	Inches white liquor from measuring tank						
16.4	82	83	84	85	86	87	88
16.5	82	83	84	85	86	86	87
16.6	81	82	83	84	85	86	87
16.7	81	82	83	84	84	85	86
16.8	80	81	82	83	84	85	86
16.9	80	81	82	83	83	84	85
17.0	79	80	81	82	83	84	85
17.1	79	80	81	82	83	83	84
17.2	78	79	80	81	82	83	84

Table IV

Corrected liquor volume, in.	*Thousand pounds wet chips*	*Specified cooking tables* 12	13	*Corrected* 14	*cooking* 15	*tables* 16	17	18
147	65	7	8	9	10	11	12	13
147	66	8	9	10	11	12	12	13
146	67	9	10	10	11	12	13	14
145	68	9	10	11	12	13	14	15
144	69	10	11	12	13	14	14	15
143	70	11	11	12	13	14	15	16
143	71	11	12	13	14	15	16	17
142	72	12	13	14	15	16	17	18
141	73	13	14	15	16	17	18	18
140	74	13	14	15	16	17	18	19
139	75	14	15	16	17	18	19	20
139	76	15	16	17	18	19	20	21
138	77	15	16	17	18	19	20	21
		18.0	18.2	18.4	18.6	18.8	19.0	19.2

Chemical treatment based on active alkali as NaOH and m.-f. wood

As soon as the digester is full of chips, the chip weight and cooking tables determine the final inches of cooking liquors to use from the measuring tanks.

In the system of using two charts and chip weight, the last 10 inches of white and weak black liquor were run in after the digester was loaded full of chips. While the digester loaders replace the cap on the digester, the balance of the cooking liquors are added. Therefore, no delay is experienced.

In Table IV, cooking on specified cooking table 14 with a digester wet chip charge of 70,000 pounds will require a corrected cooking table of 12 and a corrected total liquor volume of 143 inches (derived from Table II column J).

Applying the corrected cooking table of 12 to Table III and the white liquor testing 16.8 ml. of active alkali will give 83 inches of white liquor to use from the measuring tank. Subtracting the 83 inches of white liquor volume from 143 inches of corrected total liquor volume will give 60 inches of weak black liquor to use from the measuring tank.

CONCLUSIONS

The results of Fig. 1 and Table II indicated that with increasing chip moisture the chips become heavier and pack more moisture-free wood per digester charge. This causes the ratio of chip moisture to the moisture-free chips to increase.

It is shown how cooking tables can be designed with the aid of a weighing device so as to secure a close control of the ratio of active alkali to moisture-free wood and a discussion of two methods of correcting for moisture. First, by maintaining a close control of the ratio of chip moisture to moisture-free wood; second, by maintaining a close control of the ratio of total digester liquid volume (chip moisture, weak black and white liquor volume) to moisture-free wood.

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Effect of Urea and Related Compounds on the Mechanical Properties of Paper

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The plasticizing action of ureas and formamides has been definitely shown to be due to the effectiveness of the plasticizer molecules themselves, and not to any hygroscopic characteristics of the materials. A study of the effect of ureas and formamides on the load-elongation properties of an alpha sheet has shown that, like water, these materials reduce the tensile strength and elastic modulus of a sheet while enhancing its ability to flow under stress. The urea type of plasticizer has been shown to form bonds with the cellulose—probably hydrogen bonds between the urea carbonyl group and the cellulose hydroxyl groups. The formation of this bond is believed to satisfy reactive hydroxyl groups on the cellulose which would otherwise be involved in moisture sorption, so that one of the effects of the initial increments of a urea additive is a reduction of the moisture content of the sheet. The effectiveness of the urea plasticizers is probably due to their ability to reduce in number and strength the secondary cohesive forces which are largely responsible for the mechanical strength characteristics of the fiber-to-fiber bonds and the fibers in a sheet. The presence of these additives in the cellulosic structure is believed to maintain the cellulose in a state of dry swelling by a mechanical separation of cellulosic chains or chain bundles. The importance of the molecular size of the plasticizer molecule in determining its ability to prevent the deswelling of the cellulosic sheet on drying has been demonstrated. In addition to its effect on the manner in which a sheet reacts to stress, urea has been shown to reduce the shrinkage forces set up in a sheet during drying.

It has been a rather general belief in the paper industry that, in order to flexibilize a sheet of paper, an additive compound must have hygroscopic properties which enable it to bring water into the sheet. The close relationship between the hygroscopic powers and the plasticizing effectiveness of the usual paper softeners has been emphasized by many authors in the field. Pike (*1*) was the first to report that small amounts of such plasticizers as glycerin and invert sugar actually decrease the moisture content of paper when they are added to a sheet. Connor and Nadelmann (*2*), McPherson (*3*), and Nethercut (*4*) also found that the plasticizing action of some softeners could not be wholly explained on the basis of their hygroscopicity. The work of these authors strongly suggests that plasticizer molecules are effective *per se*, and that the effect of any hygroscopic moisture is supplemental to the effect of the plasticizer molecules themselves.

Connor and Nadelmann (*2*) visualized a paper plasticizer as being a polar molecule whose reactive group could be firmly attached to the solid face of the fibers with its less reactive, nonpolar end at a steep angle to the face. The bonding strength of the sheet was reduced, they believed, by the "boundary lubrication" provided by this monomolecular layer or partial layer of plasticizer molecules attached to the face. This lubrication effect would occur because the attraction between the molecules of lubricant would be less than either the attraction between solid faces or the attraction between the solid face and the polar end of the molecule. These authors also held that, by the same process of adsorption, the plasticizer molecules enter the fiber and cause a fiber swelling which results in reduced fiber stiffness.

McPherson (*3*) showed that treatment with glycerin reduced the internal friction of a sheet of paper, as well as its tensile strength and its flexural rigidity. His data on the effect of glycerin on the thickness and the moisture-vapor sorption hysteresis of treated sheets led him to believe that glycerin entered the cellulosic structure and kept it in a semiswollen state. He concluded that the effect of glycerin on paper is the result of a weakening of the fiber-to-fiber bonds by this swelling mechanism.

Nethercut (*4*) studied the effect of various plasticizers on the dynamic stiffness of rayon filaments, ramie fibers, and ramie sheets. Although he found that fiber stiffness was reduced by most of the plasticizers, he concluded that the reduction in sheet stiffness caused by plasticizing was due largely to the changes occurring in the fiber-to-fiber bonds.

Seemingly contradictory conclusions were reached by Reed (*5*) and Speel (*6*) on the effect of the molecular size of the plasticizing molecule. Reed reported that the plasticizing action of a series of aliphatic esters of gluconic acid increased with the size of the esterifying alcohol molecule, whereas Speel found that increasing the chain length of the polyalcohols decreased their plasticizing effectiveness on paper.

Ott (*7*), in generalizing on the action of plasticizers for cellulosic derivatives, viewed plasticizing as a solvation of the polymer chains which increases the average distance between them and thus reduces the forces acting between neighboring molecules. The reduction of cross-linking forces serves to increase the material's flexibility by increasing the amplitude of the internal movement of the chains. Craver (*8*) agreed with Ott in that he considered plasticizers to be high boiling solvents which replace polymer-polymer bonds with polymer-solvent bonds. Liebhafsky, Marshall, and Verhoek (*9*) also considered the plasticizing of polyvinyl chloride to occur along these lines.

Baker, Fuller, and Pape (*10*), in their work on cellulose acetate, concluded that a lower elastic modulus resulted when the high interchain forces resulting from the hydrogen bonding of residual hydroxyl groups were used in bonding a plasticizer. Meyer (*11*) has stated

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that forces acting between cellulosic hydroxyl groups can be diminished by intermicellar swelling agents. Nickerson (*12*), likewise, believed that water, and possibly other plasticizers, accomplished the rupturing and weakening of the —OH . . . O— cross linkage in cotton by combining with and deactivating hydroxyl groups and by increasing molecular distances so that the residual valence forces are greatly reduced in potency.

In recent years urea has found increasing use as a plasticizing and softening agent for paper. The literature contains a number of instances where the use of urea (or materials closely resembling urea in structure) has been patented for the plasticizing of cellulosic sheets (*13–16*) and paper (*17–21*).

OBJECT OF THE INVESTIGATION

Despite its technological importance to the paper industry, the action of urea on paper has never been comprehensively investigated.* The plasticizing action of urea is of particular interest from the theoretical standpoint, because urea lacks the hygroscopic characteristics generally associated with paper plasticizers and because it probably lacks a hydroxyl group which some investigators (*2*) have felt is a prerequisite for plasticizing ability. It is possible, of course, that urea undergoes a tautomeric keto-enol shift to produce an enolic hydroxyl group. For both practical and theoretical reasons, therefore, the study of the mechanism of urea-plasticizing seemed justified.

The load-elongation (LE) curve was selected as the means by which to evaluate the effect of the ureas on the mechanical properties of paper. Recent investigations of the LE characteristics of paper have indicated that these properties are tools of great potential utility in furthering the understanding of the mechanical behavior of paper. For a review of the work in this field the reader is referred to a recent paper by Van den Akker (*22*). In the present study of plasticizing it was felt that the LE curve would give more information of fundamental significance than any other single physical test. At the same time, it was hoped that the data obtained might aid in the understanding of the significance of the various LE properties of paper and the manner in which they are affected by changes in the sheet.

The work undertaken actually included: (1) a study of the effect of urea and a few related compounds on the LE curve of alpha pulp handsheets and the effect of varying humidity conditions on the LE characteristics; (2) a study of the effect of urea on other related sheet properties; and (3) a study of the effect of substitution in the urea molecule on its ability to alter the viscoelastic properties of paper.

METHODS AND PROCEDURES

The sensitivity of the LE curve to variability in handsheets, coupled with the difficulty of reproducing the beating cycle of a pulp, made it necessary to produce all the handsheets for testing at one time. Accordingly, a large number of handsheets was prepared by the standard method (*23*) from an alpha pulp beaten to a Schopper-Riegler freeness of 640 ml. From these about 300 standard sheets were selected which met visual cleanliness and formation standards, and whose basis weights and densities fell within the limits: basis weight, 61.3 to 62.3 pounds (25 × 40—500); density, 0.732 to 0.755 gram per cc. The accepted sheets were then made up into testing groups of four sheets so that, in any one group, the means of the basis weights and the densities of the sheets fell as close to the median of the limits as was possible. By this careful sheet preparation and selection procedure sheet-to-sheet variability in the test results was reduced to the practical minimum. The various additive compounds were introduced into the standard sheets (which were stored at 50% R. H. and 73 °F. prior to use) by soaking the sheets in solutions of the compound. After being pressed between blotters for three minutes at 50 p.s.i., the sheets were dried on plates in the established manner (*23*). In all instances where the additive was water soluble, the material was applied to the sheet from aqueous solution. In a few specific instances it was necessary to apply the materials in 95% ethyl alcohol because of their insolubility in water.

Sheets which were tested at 73 °F. at humidities other than 50% R. H. were conditioned in long polyethylene sleeves through which passed a stream of properly conditioned air. After the samples had reached moisture equilibrium, the polyethylene sleeves were heat-sealed into separate bags, so that each sample was enclosed in a water-vaporproof bag containing air at the conditioning humidity. The samples were then tested without removal from the bag by clamping the sample through the walls of the polyethylene bag. Care was taken to have enough accordion folds in the walls of the bag that the bag itself required no appreciable load to extend to the maximum elongation of the paper sample.

A Baldwin universal tester was used to obtain the LE curve of the test strips. A 0–120-pound range air cell was used in conjunction with the Tate-Emery load indicator to detect changes in the load on the sample and to actuate the load-recording mechanism. A microformer deflectometer measured the extension of the sample and transmitted this information to the microformer recording system.

To test the 2-inch wide test strips, they were inserted into the jaws of the instrument which were set at an initial span of 4 inches. The sample was extended at a constant rate of elongation of 0.05 inch per minute. Since it was desired to obtain a LE curve containing a deload-load loop, the sample was extended an arbitrary 0.0625 inch (1.56%) at the constant rate; the jaw movement was then reversed and the sample allowed to contract at the same constant rate. At the point where the sample just lost all its load, jaw movement was again reversed, and the sample extended to failure at the same rate of elongation of 0.05 inch per minute.

All the treated samples tested were analyzed immediately after the test for additive content and moisture content. Additive content was determined by a modified Hengar Kjeldahl nitrogen analysis which combined the distillation and titration methods of Wagner (*24*) and Ma and Zuazaga (*25*). Since some additive compounds which were volatile or were subject to decomposition at elevated temperatures were used, the Karl

* Börje Steenberg presented a paper entitled "Preliminary results on the nature of the paper bond by studies of softening with amides" at the Fundamental Research Conference in Quebec, P. Q., May 31, 1950, which was not available to the author.

Fischer moisture reagent was employed for the moisture analyses. The split reagent procedure of Johansson (*26*) was used in conjunction with a modified McKinney and Hall (*27*) titrimeter. All moisture contents and additive contents were expressed on the basis of the dry, additive-free cellulose.

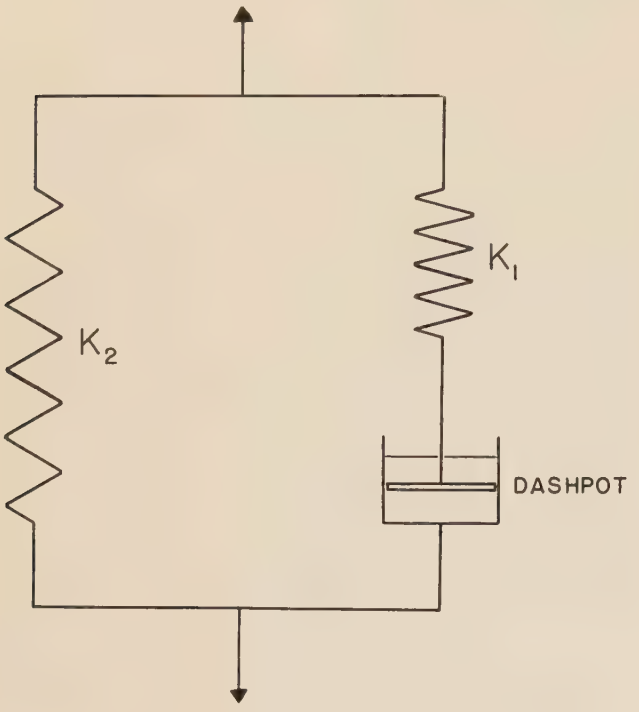

Fig. 1. Mechanical model for strain-hardened paper

Water-vapor sorption measurements were made by the convenient apparatus described by Wink (*28*). The tearing strength of paper was determined according to the standard procedure (*29*). The zero-span tensile strength measurements were made in accordance with a prescribed procedure (*30*), utilizing the most recent modification of the zero-span jaws to be developed at The Institute of Paper Chemistry.

Analysis of the Load-Elongation Curve

In stress-strain work on visco-elastic materials, many workers have found it convenient to describe the behavior of the materials in terms of hypothetical models built up of elastic springs and viscous dashpots. This type of analysis has proved to be particularly useful as an aid in the separation of the elastic and the rheological characteristics of the material. However, the fact that a model may be used to satisfactorily explain the form of a stress-strain curve does not, in itself, mean that the elements of the model have submicroscopic counterparts in the structure of the material. This is particularly true of a substance as complex structurally as paper, which is made up of a vast number of elements, each of which may exhibit visco-elastic properties and each of which may, therefore, be represented by a visco-elastic model.

The mechanical model of Fig. 1 was used by Eyring and Halsey (*31*) to describe the behavior of rayon filaments and was found by Ivarsson and Steenberg (*32*) to fit the behavior of mechanically conditioned papers. The latter authors have described how the model of Fig. 1 acts to form a LE curve of the type shown in Fig. 2.

In this work the model of Fig. 1 was used as a basis for the analysis of the LE curve. The methods of graphical analysis introduced by Ivarsson and Steenberg (*32*) and described more fully in later papers (*33*, *34*) have been utilized. A brief discussion of the various values taken from a typical LE curve of the type shown in Fig. 2 will serve to acquaint the reader with these quantities.

(1) The *tensile strength* of the standard 2-inch wide test strip expressed as pounds is *a* in Fig. 2.

(2) The total elongation of the sample at failure (*b*) is expressed as a percentage of the total length and termed *stretch* in this paper.

(3) The initial slope of the LE curve (*c*/*d*) is expressed in pounds per mil; and for the constant cellulosic cross section of all the test strips, this is proportional to the Young's modulus of the strip. If the model of Fig. 1 is allowed to represent the standard 2-inch test strip tested at 4-inch span and having the standard cellulose cross section, then the initial slope may be equated to $K_1 + K_2$.

(4) The slope of the latter linear or near-linear portion of the curve will be termed the *final slope* and will be equated to the spring constant K_2 of the model. The final slope is *e*/*i* in Fig. 2, and has the units of pounds per mil.

(5) The value of the *series spring constant* K_1 of the model in Fig. 1 is readily seen to be equal to the initial slope less the final slope. Since this value accounts for about 90% of the initial slope value, the behavior of the initial slope value is generally the same as that of the series spring constant K_1. Only the values for K_1 and K_2 will be given in this paper. The reader who is particularly interested in the behavior of the Young's modulus of the cellulose may add the two values to obtain the initial slope value.

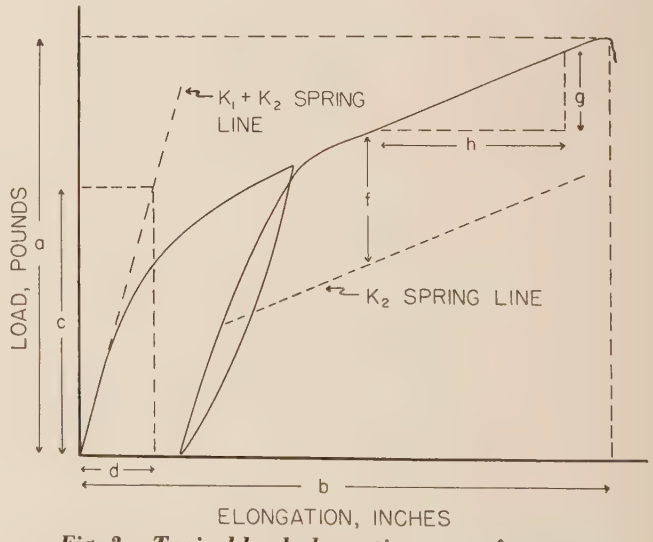

Fig. 2. Typical load-elongation curve for paper

(6) Andersson, et al. (*34*), have shown how it is possible to use the model of Fig. 1 to determine the relative viscosity of the dashpot fluid during the region of the curve where dashpot movement is occurring. By suitable graphical analysis of the LE curve it is possible to isolate values for the rate of dashpot flow

and the force required to cause that rate of dashpot flow at a given point on the LE curve. From these two quantities it is possible to calculate a relative viscosity value for the dashpot fluid. Of particular interest is the limiting relative viscosity of the dashpot fluid in the region where the rate of dashpot flow is equal to the rate of elongation. It turns out that the force on the dashpot required to cause this rate of flow is equal to the quantity, *f*, in Fig. 2, which is the distance between the LE curve and a suitably drawn spring line. This quantity will be termed the *limiting viscous load* or the *f value*. For a given cellulosic cross section and a given strip length it is proportional to the limiting relative viscosity of the dashpot fluid during the region of constant rate of dashpot flow.

EXPERIMENTAL RESULTS

Distribution of Urea Through a Handsheet

An investigation of the distribution of urea through some typical urea-treated handsheets by a Scotch tape stripping method showed that, regardless of whether a sheet was dried for 2 hours or 2 days, the center of the sheet contained more urea than the surface regions. In some instances, the center of the sheet was found to have nearly double the urea content of the edges. This may be interpreted as evidence that at least a major portion of the urea migrates with the free water in a sheet until the water is evaporated and, therefore, is not selectively sorbed by the cellulose in the presence of an excess of water. This conclusion is further supported by the fact that the urea can be quantitatively washed from a pulp pad with a minimum of washing. Therefore, if a cellulose-urea bond does form, it probably forms at a point in the drying where the cellulose is giving up its bound water to the air.

Effect of Urea on the Cellulose-Water Relationship

Careful determination of the water-vapor sorption isotherm for crystalline urea showed that, at relative humidities below 65%, urea sorbed less than 0.02% moisture. At 80% R. H., however, urea was deliquescent. The water-vapor sorption isotherms for urea-treated pulps conclusively demonstrated that the initial increments of urea in a pulp decrease its moisture content at relative humidities below 50%. As the relative humidity increases, however, the moisture contents of the treated pulps rise until, in the 60 to 80% R. H. region, they exceed that of the untreated pulp. The point at which the treated pulp isotherm crosses the untreated pulp isotherm was found to occur at a lower humidity the higher the urea content of the pulp.

Measurement of the area of the moisture vapor sorption hysteresis loop for urea-treated and untreated pulps showed that a 3.7% urea content pulp had a loop area only 85% of that of the alpha pulp, whereas a 7.7% urea content pulp hysteresis loop had an area only 73% of that of the untreated pulp.

These results indicate that urea, like glycerin (*3*), actually forms a bond with certain reactive cellulose groupings which normally sorb moisture. It is believed that urea in aqueous solution enters into the fibrous structure of paper when it is in a state of intermicellar swelling and remains behind when the water is evaporated to keep the cellulose in a state of partial dry swelling. The maintenance of this dry-swollen state prevents the formation of interchain cross linkages which are responsible for at least a part of the hysteresis effect.

Effect of Urea on Sheet Shrinkage During Drying

An alpha pulp sheet dried from 10% urea solution was found to exhibit considerably less shrinkage on drying than one dried from water. To investigate the role of the urea during the drying of a sheet, measurements were made on the shrinkage tension developed in resoaked sheets dried at constant length from water and from a 10% urea solution. The shrinkage tension was measured by using a 0 to 12-pound range air cell in the Baldwin instrument, and the drying curve of the strip was obtained by determining the moisture content of control samples hanging near the test strip. The duplicate samples run in both instances showed a good reproducibility of the shrinkage tension-moisture content curves despite the relative crudity of the drying determination.

Table I gives the data obtained on the development of shrinkage tension in sheets dried from water and 10% urea. The data show that the presence of the urea reduced both the maximum shrinkage tension attained before the rate of stress relaxation equaled the rate of shrinkage tension development, and the shrinkage tension of the sheet at any given moisture content level. The most striking difference between the two sheets, however, occurs at moisture contents below 12%. In this region the extremely rapid rise in shrinkage tension exhibited by the normal sheet does not occur in the urea-soaked sheet. Since data obtained on the development of tensile strength during the drying of a resoaked sheet from water did not indicate any rapid rise in tensile strength (and hence, by inference, bonding strength) in this moisture content region, it must be assumed that the sharp rise in shrinkage tension of the water-soaked sheet was due to a final shrinking, twisting, or coiling tendency of the fibers. The presence of the urea either modified this final fiber shrinkage very considerably, or else so weakened the fiber-to-fiber bonds that they were unable to stand up under the resulting shrinkage stresses.

Table I. Effect of Urea on the Development of Shrinkage Tension During Drying

Sheet dried from	Shrinkage tension, lb./2-inch strip at a moisture content (dry pulp basis) of: 60 %	50 %	40 %	30 %	20 %	15 %	12 %	10 %	9 %
Water	0.08	0.37	0.83	1.63	2.94	3.76	4.34	5.05	6.04
10% Urea	0.00	0.14	0.39	0.86	1.69	2.38	3.01	3.70	4.10

The effect of the urea during the drying of a sheet is probably the result of several actions: (1) the urea may reduce the extent to which the deswelling of the fibers occurs by its very presence in the intermicellar regions; (2) the urea may reduce the strength or the number of the internal cohesive bonds formed in the drying fibers and, thus, facilitate the flow of molecular chains or micelles past one another to relieve shrinkage stresses; or (3) the urea may reduce the strength of the fiber-to-fiber bonds and enhance their ability to flow under stress, so that the bonds, also, are capable of relieving some of the shrinkage stresses set up in the sheet.

It is of interest to note that the data of Table I are not in agreement with the findings of Lyne and Gallay (*35*) who found that freshly formed bleached sulphite and groundwood handsheets developed practically all their shrinkage tension before drying to a moisture content of 25%.

Effect of Urea on the Load-Elongation Curve at 50% R. H.

The average values obtained from the LE curves of sheets treated with varying amounts of urea and tested at 50% R. H. in groups of four are given in section A of Table II. The initial effect of the urea is seen to be a reduction in the tensile strength, the two elastic moduli (K_1 and K_2), and the f value, and an increase in the extensibility of the sheet. It will be remembered that the initial slope value generally behaves in the same way as the series spring constant K_1. The permanence of the effects reported has not been investigated. However, it is believed that the nature of the changes is such that no fugitive effects would normally be expected.

Since this action of urea is typical of the action of water and all the other urea compounds investigated, it seems justifiable at this point to define the term plasticizer in terms of an additive's effect on the load-elongation curve for paper. In connection with this work the term plasticizer will henceforth be used to denote a compound which reduces the tensile strength and elastic moduli of a sheet and which improves the flow properties of the sheet as evidenced by a decrease in the limiting viscous load (f). The behavior of the stretch value on plasticizing does not always follow the trend shown by urea in Table II and, therefore, generalization concerning the behavior of stretch on plasticizing is hazardous.

Table II. Effect of Urea on the Load-Elongation Properties

Urea content (dry pulp basis), %	*Tensile strength, lb./in.*	*Final slope (K_2), lb./mil*	*Series spring constant K_1, lb./mil*	*f value, lb.*	*Stretch, %*
Section A—Actual Values					
0	20.9	0.14	1.33	17.7	2.87
2.8	20.1	0.14	1.27	16.2	2.99
5.3	19.2	0.14	1.18	14.8	3.21
9.5	17.5	0.13	0.94	12.4	3.63
15.4	14.7	0.11	0.57	8.5	4.39
18.7	12.8	0.10	0.45	6.2	4.69
23.4	14.7	0.12	0.64	7.3	4.98
34.2	17.3	0.15	0.74	7.9	4.52

Urea content (dry pulp basis), %	*Bonding strength factor*	*Adjusted tensile strength*	*Adjusted final slope K_2*	*Adjusted series spring constant K_1*	*Adjusted f value*
Section B—Values Adjusted to Common "Bonding Strength"					
0	0.407	51.2	0.34	3.27	43.5
2.8	0.391	51.2	0.36	3.26	41.4
5.3	0.369	52.1	0.37	3.20	40.1
9.5	0.332	52.7	0.40	2.83	37.3
15.4	0.296	49.7	0.38	1.92	28.7
18.7	0.259	49.4	0.38	1.73	23.9
23.4	0.315	46.5	0.37	2.04	23.2
34.2	0.372	46.4	0.39	1.99	21.2

It will be noted from the data of section A, Table II, that, above a urea content of 18.7%, the plasticizing action of the urea is reversed. Tensile strength, the elastic moduli, and f all begin to increase. It is believed that, at this point, the urea has saturated the cellulose and that, as a result, free urea has crystallized in and around the fibers during the drying process in such a way as to impart greater rigidity and strength to the sheet. This crystallization effect was also noted in other sheets treated with urea-type additives. It was observed at high urea concentrations by Nethercut (*4*) in his work on rayon filaments.

A complete graphical analysis of some of the LE curves of urea-treated sheets was carried out by the method of Andersson, *et al.* (*34*). The family of curves which was obtained when relative viscosity was plotted against the load on the dashpot showed that, with increasing urea content, both the initial viscosity of the dashpot fluid and the final limiting relative viscosity of the fluid are reduced. The breakdown of viscosity also occurred at a lower load when more urea was present in the sheet.

Effect of Urea on Tearing Strength and Zero-Span Tensile Strength

The internal tearing strength and the zero-span tensile strength of urea-treated papers were determined at 50% R. H. with the results shown in Table III. It is obvious that treatment of a sheet with urea has very little effect on its tearing strength. Statistical treatment of the data did show, however, that the initial decrease and the subsequent increase in the region of 15% urea were statistically significant.

Table III. Tearing Strength and Zero-Span Tensile Strength of Urea-Treated Handsheets

Strength property	*Urea content of sheet (dry pulp basis), %*							
	0	*2.8*	*5.3*	*9.5*	*15.4*	*18.7*	*23.4*	*34.2*
Tearing strength, g./sheet	92.8	91.7	90.1	93.3	95.5	89.6	90.7	85.3
Zero-span tensile strength, lb./in.	51.2	51.2	52.1	52.7	49.7	49.4	46.5	46.4

Statistical treatment of the zero-span tensile strength data showed that the initial rise in strength could not have occurred by chance more than 1% of the time. In other words, zero-span tensile strength probably does increase slightly when small amounts of urea are added to the sheet. Since the introduction of urea into the sheet may change such variables as the effect of clamping on the fibers in the nip, it is not possible to definitely state from these data that fiber strength is increased by urea plasticizing. However, it does seem obvious that fiber strength, as measured by the zero-span tensile strength test, is not significantly reduced by the first increments of urea in the sheet. Presumably the urea sufficiently reduces internal cohesive forces in the fibers to allow a more uniform distribution of stress between individual molecular chains or bundles of chains. The improvement of stress distribution has previously been advanced as an explanation for the increase in the tensile strength of cotton fibers when they are plasticized with moisture (*36–38*) and glycerin (*3*).

The immediate inference to be drawn from the zero-span tensile strength data is that the major cause of the decrease in actual tensile strength with urea plasticizing is the weakening of the fiber-to-fiber bonds. This does not necessarily imply, however, that the major

cause of decreased elastic moduli or increased flow properties also lies in the fiber-to-fiber bonds since, in the case of cotton fibers, it is known that fiber tensile strength increases under conditions which lower fiber rigidity.

The ratio of the actual tensile strength to the zero-span tensile strength has been used as an index of bonding strength, since it is presumably a measure of the ability of the bonds to realize the ultimate tensile strength attainable in a sheet if failure were caused only by fiber rupture. If the values for some of the properties of urea-treated sheets are adjusted to a unit bonding strength by the use of this bonding strength factor, it should be possible to obtain some idea of the magnitude of the role bonding strength plays in altering these properties. This has been done in section B of Table II, where the various values from section A of the same table have been "adjusted" to a common bonding strength by division by the bonding strength factor.

Section B of Table II shows that the bonding strength factor decreases to a minimum value of less than 65% of its original value at a urea content of 18.7%. Thereafter, it rises to about 90% of its original value because of the crystallization phenomenon.

It is seen that the changes in tensile strength and final slope occurring at low urea concentrations may be almost completely explained on the basis of the bonding strength change.

In the case of the series spring constant K_1, however, some factor or factors equally as important as bonding strength changes are operating to reduce the value of K_1. It is presumed that this factor is the flexibilizing of the fibers. The fact that the adjusted K_1 value increases after the crystallization point is reached gives support to this view. The slow drop in the adjusted K_1 value with the first small amounts of urea might be interpreted as an indication that a certain minimum amount of urea must be present in the structure before its flexibilizing effect on the fibers is comparable with its effect on the fiber-to-fiber bonds. In view of the probable highly disordered nature of the cellulose units involved in the fiber-to-fiber bond, it seems logical that this region would be more immediately sensitive to small amounts of plasticizer than the more ordered, amorphous portions of the fiber.

The adjusted f value decreased throughout the entire urea content range investigated. The changes in bonding strength, therefore, are insufficient to explain even a major part of the changes in this property. It is interesting to note that, although bonding strength and, presumably, fiber stiffness increase in the region of crystallization, the factor operating to reduce the flow properties continues to effect a decrease in the f value in this region. It seems possible that the degree of dry swelling of the fiber and the bonds is of importance here, since dry swelling will probably continue to increase even in the region of crystallization.

The above discussion is not intended to prove that bonding strength does or does not account for changes in specific sheet properties. Obviously other factors which change to the same extent and in the same manner as bonding strength may be responsible for the particular changes occurring in the sheet property. It is of interest, however, to note that the values of K_1 and f change considerably more on plasticizing than does the bonding strength, whereas the tensile strength and K_2 change to about the same extent as the bonding strength.

Comparison of the Effect of Urea on Properties at 50% R. H. and 11% R. H.

Some of the urea-treated sheets tested at 50% R. H. were conditioned at 11% R. H. and 73°F. and tested at this humidity level. From these data, a comparison of the plasticizing effectiveness of the compound at the two humidity levels was possible. The plasticizing effectiveness of the urea at any given urea content with regard to any such property as tensile strength was taken to be the difference between the tensile strength of the treated sheet and that of an untreated sheet dried from water to the same moisture content as the treated sheet. The data on the untreated sheets were obtained by investigating the effect of moisture on the LE quantities of the standard sheets in a series of experiments which will not be discussed here. The absolute difference in strength properties between the treated and the untreated sheets was compared at the two humidity levels, as was the percentage difference which was obtained by expressing the absolute difference as a percentage of the untreated sheet's value. Unfortunately, space limitations do not permit inclusion of these data.

In general, urea was considerably more efficient as a plasticizer at 50% than at 11% R. H. On a percentage basis, urea was almost 100% more effective in reducing tensile strength at 50% R. H. than at 11% R. H. The absolute change in stretch was considerably greater at 50% R. H. but, on a percentage basis, the urea was roughly equally effective at both humidity levels. The effectiveness of urea in reducing the absolute value of the series spring constant K_1 was almost 50% greater at the higher than at the lower humidity. Expressed as a percentage of the K_1 value of the untreated sheet, the urea was twice as effective at 11% R. H.

The final slope value K_2 was the only property more profoundly affected by plasticizing at the lower humidity level. Both on an absolute and a percentage basis, K_2 was reduced more at 11% R. H. than at 50% R. H. A possible reason for this will be discussed in a subsequent section of this paper.

The absolute reduction in the f value due to urea was almost the same at the two humidity levels. On a percentage basis, the urea was almost 50% more efficient at 50% R. H. than at 11% R. H.

It is of interest to observe that 1,3-dimethylurea, which was found to be a better plasticizer at both 50% R. H. and 11% R. H. than urea, was found to lose less of its tensile strength-, K_1, and f value-reducing powers at 11% than urea. This prompts the observation that the same properties of an additive which determine its plasticizing efficiency at a given humidity level are probably of importance in determining how much of its efficiency is retained at low humidities. The reason for the greater plasticizing efficiency of the 1,3-dimethylurea will become apparent when the comparative data for the various substituted ureas are discussed.

Effect of Some Volatile Additives on Sheet Properties

A study of the LE properties of soaked sheets dried

plasticizer-free from such volatile plasticizers as pure formamide, dimethylformamide, and aqueous solutions of these compounds showed that the presence of a plasticizer molecule during the drying of a sheet has a significant weakening or plasticizing effect on the LE properties of a sheet. This result was anticipated from the study of the effect of urea on shrinkage tension, since it is known from the work of Edge (*39*) and others (*40*) that drying tension may have a very important effect on sheet properties. The changes brought about in a sheet through the presence of a plasticizer during the drying process, however, were found to be secondary in importance to the effect of the plasticizer molecules on the actual sheet-straining mechanism.

The fact that volatile plasticizer molecules may be sorbed by the cellulose from the vapor phase, with a resultant effect on sheet properties, was demonstrated by hanging test strips for a period of 2 months in an atmosphere desiccated by phosphorus pentoxide and containing formamide vapor. The LE properties of these strips tested after reconditioning to 50% R. H. showed that a given amount of sorbed formamide was even more effective in plasticizing the sheet than the same amount of formamide which had been left in a sheet dried from pure formamide. The difference between the effect of the sorbed formamide and the residual formamide was probably due to the stress-relaxation which occurred in the hanging strip but which could not occur in the sheets dried under restraint from pure formamide. The experiment illustrates the point that there is nothing unique about the ability of water vapor to plasticize a sheet of paper by being sorbed on receptive cellulose groupings.

Comparison of the Effect of Various Ureas and Formamides on Paper

In order to investigate the effect of an alteration of the urea molecule by substitution on the effectiveness of the compounds in altering the mechanical properties of paper, a variety of methyl-, ethyl-, and butyl-substituted ureas were applied to standard handsheets and the properties of the treated sheets were evaluated. No effort was made to evaluate the permanence of the observed effects.

Ideally, a comparison of the effect of various additives on the mechanical properties of paper should be carried out at a constant moisture content. Because of the dehydration effect of the additives on the cellulose, this would require different humidity conditions for each set of sheets. Since this course of action was unfeasible, it was decided to do all testing at the standard conditions of 50% R. H. and 73 °F. and to correct for the moisture content of the sheet so that the effect of the various compounds could be compared on a uniform basis. In correcting for moisture content changes, the effect of an additive was defined to be the relative difference between the value of the property in an untreated sheet and that in a treated sheet when both are at the same moisture content. For any given sheet this moisture content was its equilibrium moisture content at 50% R. H. The plasticizing effect of a given concentration of additive with reference to any one property was taken to be this difference between treated and untreated sheets, expressed as a percentage of the value of the untreated sheet.

It will be seen that, from the above definition, a compound which, for example, does not alter the tensile strength of a sheet but does reduce its moisture content, is considered to have reduced the tensile strength. In the absence of the additive the same moisture content change would have produced an increase in tensile strength, so that the additive has, in effect, substituted its tensile strength-reducing powers for those of the moisture which it displaced.

The LE properties of the standard sheets at various moisture contents were determined by drying sheets soaked in water to various humidities under restraint. Since all the plasticized sheets were dried to their equilibrium moisture content under restraint, it was important that the untreated sheets with which they were compared likewise reach equilibrium under drying restraint. The data thus obtained, when plotted against moisture content, gave curves from which the properties of a sheet of any moisture content could be obtained.

A list of the substituted ureas and formamides investigated and the number of additive concentrations studies in each case is as follows: urea, 1,3-dimethylurea, formamide, and dimethylformamide—8 or more points each: 1,1-dimethylurea—6 points; 1,3-diethylurea and methylurea—4 points each; ethylurea and 1,1-diethylurea—3 points each; thiourea, tetramethylurea, 1,3-diethylthiourea, butylurea, 1,1-dibutylurea, 1,3-dibutylurea, and tetrabutylurea—2 points each. Four strips were tested at each additive concentration; the average of the test results of the four strips is reported. The mechanical property values obtained were plotted against additive content, and the tabulated values were taken from these curves at additive concentration intervals of 25 millimoles per 100 grams of dry pulp. These values were then compared with the values for an untreated sheet at comparable moisture contents and the plasticizing effectiveness of the given additive content was calculated.

It is well to bear in mind the fact that, as a general rule, the effect of the additive compounds was found to be many times that attributable to the relatively small moisture content changes brought about by the additive. Indeed, it is very probable that the conclusions to be drawn from this work would not be altered if the moisture content changes had been neglected altogether.

In the interests of brevity, the behavior of only seven of the substituted ureas studied will be compared in this paper. The compounds have been selected so that the effect of increased substitution with one substituent group—the methyl group—can be seen, and the effect of increasing the substituent size can be seen by comparing the 1,3-disubstituted and the tetrasubstituted compounds. In all the figures shown for these compounds (i.e., Figs. 3–7), it should be remembered that the shape of the curve is determined by the values calculated from the original baseline additive content-mechanical property curves (not shown). The points are put on the curves for the sole purpose of indicating the number of experimentally determined points from which the baseline curves were plotted. In some instances the additive range plotted was only a portion of the additive content range investigated.

Because of their largely hydrocarbon nature, the

butyl-substituted ureas were not appreciably water soluble and it was necessary to apply these compounds from a less polar solvent. Ethyl alcohol (95%) was selected as the solvent for these compounds. The use of alcoholic solutions, and the fact that the formamide-treated sheets were obtained by "drying" the sheets from the pure compound, made it necessary to modify the moisture "subtraction" process for these sheets. In each case the additive-free sheet dried from the alcohol or the particular formamide in question was taken as the baseline "untreated" sheet. The magnitude of the moisture effect correction was adjusted in proportion to the relative magnitudes of the values of the mechanical property of these additive-free, baseline sheets and water-dried sheets at the same moisture content.

Undoubtedly, a certain amount of error was introduced by comparing the effect of additives applied from both aqueous and alcoholic solutions. However, it was not felt that the magnitude of the error would be sufficient to significantly alter the trends found in the investigation. A spot-check of a single urea concentration applied from both aqueous and alcoholic solutions gave good agreement between the two percentage plasticizing efficiencies calculated for the different properties. For this reason it was felt that an "across the board" comparison of all the compounds was justified.

Effect of the Additives on Moisture Content

Table IV shows the equilibrium moisture contents at 50% R. H. of the sheets containing varying amounts of the compounds studied. It is immediately obvious that the moisture contents of all the sheets decreased with the addition of small amounts of additive. Even when the compound was hygroscopic, as in the cases of formamide and dimethylformamide, there was an initial competition between the water and the additive for the sorbing groups of the cellulose.

It is widely believed that the sorbed water on cellulose is held by reactive hydroxyl groups, probably through hydrogen bonding. The replacement of water by the urea additives strongly indicates that these additives are also bonded to the hydroxyl groups. In view of the structure of the amide additives, it is very likely that they, like water, are also hydrogen-bonded to the cellulose. The fact that complete substitution of the amide nitrogen atoms does not affect the moisture-reduction phenomenon strongly indicates that the bonding group of the urea molecule is the carbonyl group. The possibility that the cellulose-urea bond forms through active hydrogen atoms on the amide groups or through an enolic hydroxyl group is thus excluded. It seems probable, therefore, that the cellulose hydroxyl oxygen atom shares its proton with the electronegative carbonyl oxygen of the urea.

Effect of the Selected Compounds on Sheet Tensile Strength

Figure 3 shows the plasticizing efficiency curves for seven of the substituted ureas. Water has been included in the figure for comparative purposes. The water content has been calculated from an 8% moisture content baseline which represents equilibrium conditions at 50% R. H. and 73°F. Little change would have been noted if a 6% moisture content baseline had been chosen. Since the other additives are plasticizing a sheet with 6 to 8% moisture content, the moisture content baseline chosen seems to be a fair one from which to judge the plasticizing effectiveness of water.

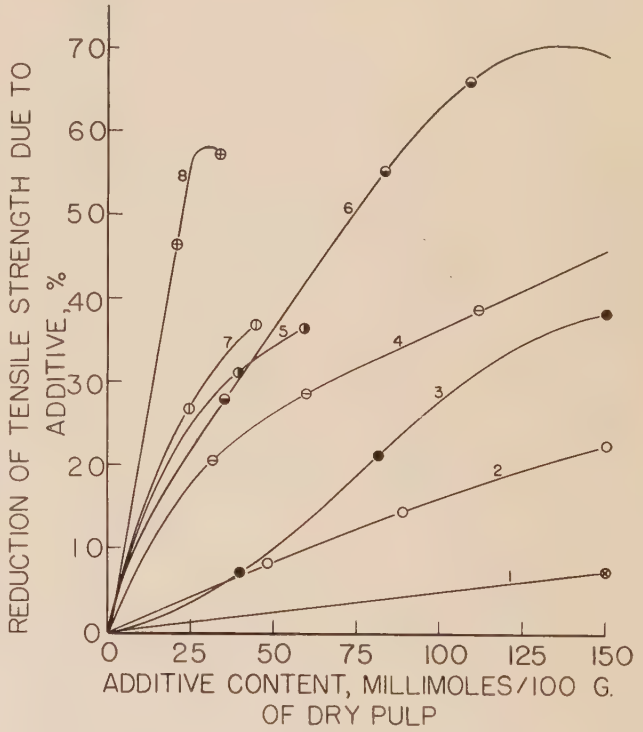

Fig. 3. The efficiency of the various compounds in reducing tensile strength

1. Water
2. Urea
3. Methylurea
4. 1,3-Dimethylurea
5. Tetramethylurea
6. 1,3-Diethylurea
7. 1,3-Dibutylurea
8. Tetrabutylurea

It is immediately obvious from Fig. 3 that water has comparatively little effect on tensile strength. The fact that, on a molar basis, water has a relatively small effect on sheet properties (amply borne out by data to follow) is in direct contradiction to the widespread concept of water as the perfect plasticizer for paper. On a weight basis, of course, the effectiveness of water may compare more favorably with that of other materials.

Substitution of urea increased its efficiency in reducing tensile strength. The more substituent groups in the urea, the more effective the compound seems to become and, at a given level of substitution, its tensile strength reducing powers seem to be enhanced by increasing the size of the substituent group. Complete substitution of the amide nitrogen atoms did not have a deleterious effect on the initial effectiveness of the molecule in reducing tensile strength. This again indicates that the cellulose-urea bonding mechanism does not require active hydrogen atoms or an enolic group and points to the carbonyl group as the bonding group.

Figure 3 strongly indicates that the molecular size of the additive molecule plays a major part in determining how effective a urea will be in reducing tensile strength. It seems probable, therefore, that the abil-

ity of a molecule to reduce secondary cohesive forces by maintaining the cellulose in a state of dry swelling is of importance to the weakening action of a plasticizer.

Effect of the Additives on the Final Slope (K_2)

Figure 4 compares the efficiency of the seven ureas in reducing the final slope value. It is evident from

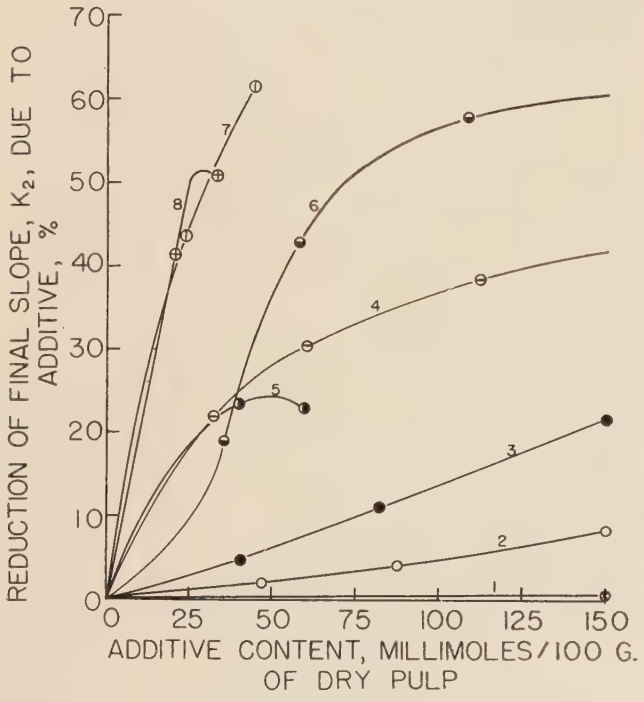

Fig. 4. The efficiency of the various compounds in reducing the final slope, K_2

1. Water
2. Urea
3. Methylurea
4. 1,3-Dimethylurea
5. Tetramethylurea
6. 1,3-Diethylurea
7. 1,3-Dibutylurea
8. Tetrabutylurea

the figure that the smaller molecules (such as water, urea, and methylurea) had a relatively small effect on this property. Again, for this property, increasing substitution and increasing substituent size resulted in a marked increase in the final slope-reducing powers of the additive. The effect of molecular size is even more striking in this instance than it was in the case of tensile strength shown in Fig. 3.

Effect of the Additives on the Series Spring Constant K_1

The curves in Fig. 5 show the effect of the ureas on the series spring constant K_1. The effect of increased molecular size is evident from this figure but it is not as clearly defined for the K_1 value as was the case for the tensile strength or the K_2 values. Increasing substitution caused an increase in K_1-reducing powers. A high degree of substitution, such as tetra-substitution, markedly increased the efficiency of the molecule in reducing the K_1 value.

At the same time, this increase in molecular size tended to lower the maximum reduction of K_1 of which the compound was capable and caused this maximum to occur at a lower molar additive content. The curves for all the ureas investigated indicated that molecules in the molecular weight range of 70–90 (such as dimethylformamide, methylurea, and 1,3-dimethylurea) seemed to have a maximum K_1-reducing

Table IV. Moisture Content of Various Treated Sheets at 50% R. H. and 73°F.
(Percentage of oven-dry pulp)

Additive compound	*Additive content of sheet, millimoles per 100 grams of oven-dry pulp* 0	25	50	75	100	125	150
Compounds Applied from Aqueous Solutions							
Urea	8.01	7.26	6.73	6.37	6.19	6.12	6.10
Thiourea	8.01	7.04	6.42	6.05	5.87	5.77	5.72
Methylurea	8.01	7.33	6.87	6.56	6.37	6.27	6.22
1,1-Dimethylurea	8.01	7.46	6.90	6.55	6.50	6.56	6.70
1,3-Dimethylurea	8.01	6.77	6.20	6.11	6.07	6.06	6.10
Tetramethylurea	8.01	7.71	7.33	..	..	..	..
Ethylurea	8.01	7.73	7.14	6.66	6.36	..	..
1,1-Diethylurea	8.01	6.98	6.41	5.98	..	..	..
1,3-Diethylurea	8.01	7.40	6.95	6.58	6.25	5.98	5.76
1,3-Diethylthiourea	8.01	7.42	..	..	..	..	..
Compounds Applied from 95% Ethyl Alcohol Solutions							
Butylurea	7.84	6.84	5.89	..	..	..	..
1,1-Dibutylurea	7.84	6.82	5.99	5.33	..	..	..
1,3-Dibutylurea	7.84	6.53	..	..	..	..	..
Tetrabutylurea	7.84	7.41	..	..	..	..	..
Sheets Dried from Pure Compound							
Formamide	7.21	6.78	6.63	6.57	6.56	6.59	6.66
Dimethylformamide	6.74	6.88	6.51	6.61	7.07	7.64	8.20

ability. In other words, although some of the higher molecular weight compounds gave a higher rate of reduction of K_1 in the low additive content ranges, these medium molecular weight compounds were capable of a

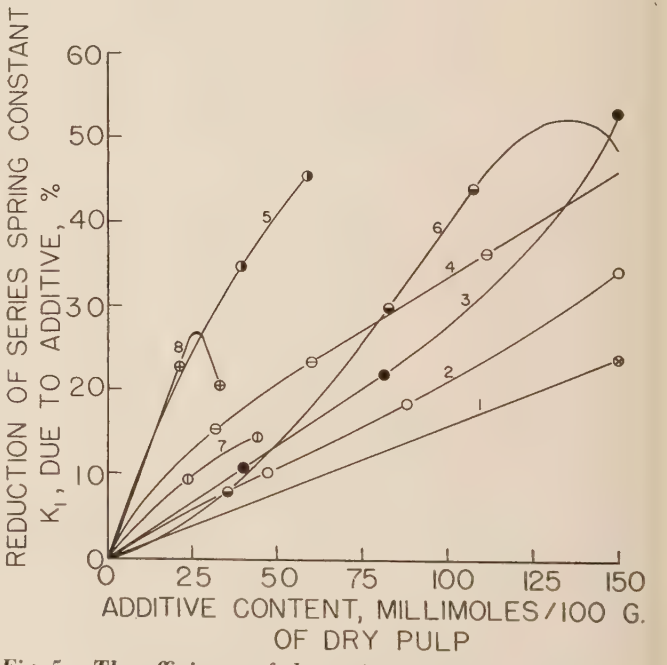

Fig. 5. The efficiency of the various compounds in reducing the series spring constant, K_1

1. Water
2. Urea
3. Methylurea
4. 1,3-Dimethylurea
5. Tetramethylurea
6. 1,3-Diethylurea
7. 1,3-Dibutylurea
8. Tetrabutylurea

sustained reduction of K_1 with increasing additive content which ultimately resulted in a greater reduction of the value.

At this point it would be well to comment briefly on the relative nature of the spring constants (K_1 and K_2). Considerable indirect evidence has been obtained which supports the hypothesis that the parallel spring constant K_2 is more sensitive to changes in bonding strength than is the series spring constant K_1 and that, conversely, K_1 is more sensitive to changes in fiber stiffness than K_2. This is not to say that both constants are not changed by any changes in the elastic characteristics of either the bonded zones or the fibers. Although it is not possible to present the evidence supporting this hypothesis, some of the sources of the evidence may be listed: (1) the behavior of the two spring constants when small polar molecules capable of swelling and entering the fiber structure are used as plasticizers on the one hand, and large hydrophobic molecules which would experience difficulty in penetrating fiber structure are used as plasticizers on the other, (2) the behavior of the two values when crystallization occurs in the sheet, (3) the remarkable sensitivity of K_2 to the molecular size of the additive molecule which is not so apparent in the changes in K_1, (4) the fact that there seems to be an optimum molecular-size range for the greatest over-all reduction of K_1, although this

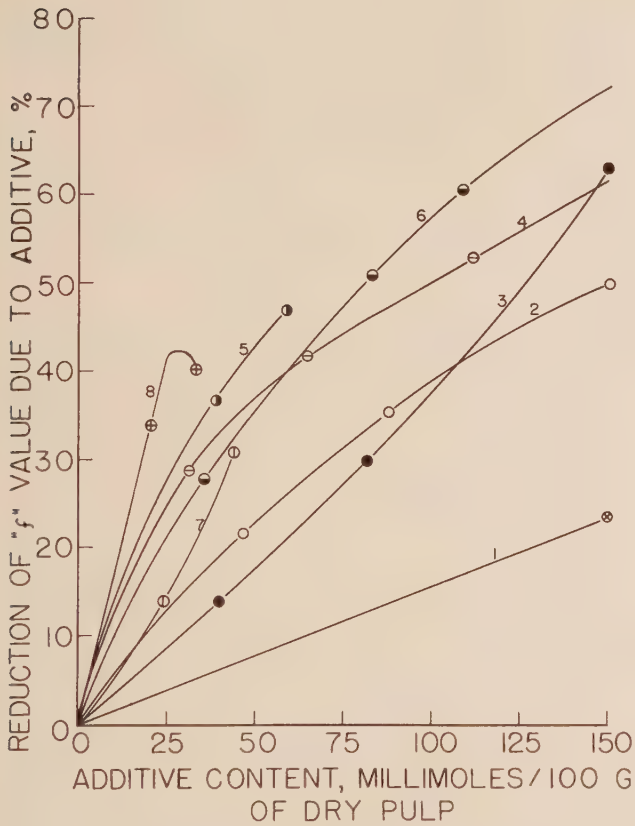

Fig. 6. The efficiency of the various compounds in reducing the limiting viscous load value, f

1. Water
2. Urea
3. Methylurea
4. 1,3-Dimethylurea
5. Tetramethylurea
6. 1,3-Diethylurea
7. 1,3-Dibutylurea
8. Tetrabutylurea

does not seem to be true for K_2, and the connection between this behavior and the probable penetration difficulties experienced by the larger additive molecules, (5) the relative effect of urea and 1,3-dimethylurea at 50% R. H. and 11% R. H. on the two elastic constants, (6) the fact that K_2 was found to be considerably more sensitive to stress relaxation phenomenon than K_1, and (7) the fact that changes in K_2 can be adequately ex-

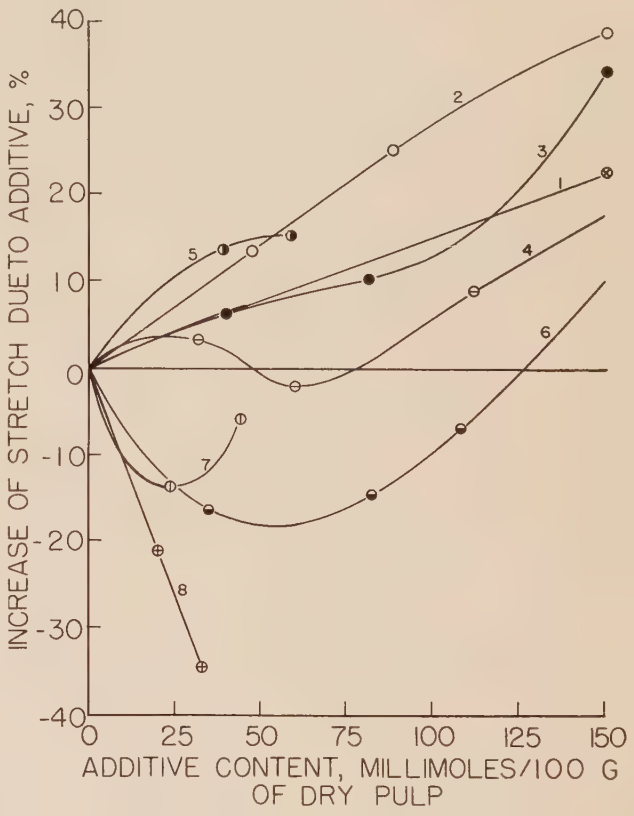

Fig. 7. The efficiency of the various compounds in increasing stretch

1. Water
2. Urea
3. Methylurea
4. 1,3-Dimethylurea
5. Tetramethylurea
6. 1,3-Diethylurea
7. 1,3-Dibutylurea
8. Tetrabutylurea

plained on the basis of the changes in bonding strength, whereas the changes in K_1 indicate the importance of some other factor, probably fiber swelling.

Effect of the Additives on the f Value

The trends indicated in Fig. 6, which shows the *f*-reducing effectiveness of the various ureas, are similar to those already noted in the discussions of Figs. 3 to 5. Water is the least effective compound in reducing *f*. In general, increasing molecular size, either by increasing the degree of substitution or increasing the substituent size, resulted in an increase in *f*-reducing powers of the additive. The comparison of all the ureas showed, however, that the dibutylureas were not significantly different from the diethylureas in their *f*-reducing powers.

Effect of the Additives on Stretch

Figure 7 shows the effect of the seven ureas on the stretch value. Only the relatively low molecular weight materials seem capable of increasing the stretch value. Water, which the previous figures have shown to be comparatively ineffective in altering the elastic and flow properties of the sheet, is seen to rank quite

high in its ability to increase stretch. As substituent size and total molecular weight increase, the additives tend to significantly reduce the stretch value before increasing it. Tetrabutylurea gave no indication of anything but a precipitous decrease in stretch.

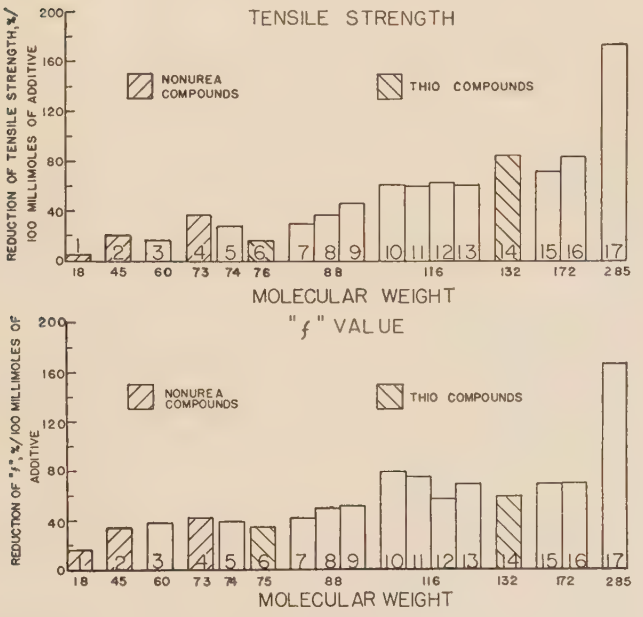

Fig. 8. Comparison of the efficiencies of the various compounds in reducing tensile strength and f, respectively

1. Water
2. Formamide
3. Urea
4. Dimethylformamide
5. Methylurea
6. Thiourea
7. 1,1-Dimethylurea
8. 1,3-Dimethylurea
9. Ethylurea
10. Tetramethylurea
11. 1,1-Diethylurea
12. 1,3-Diethylurea
13. Butylurea
14. 1,3-Diethylthiourea
15. 1,1-Dibutylurea
16. 1,3-Dibutylurea
17. Tetrabutylurea

In considering these results, it is necessary to consider the fact that a sheet of paper will continue to extend only as long as the bonding strength is adequate to resist the applied stress. As long as the bonding strength is sufficient to prevent failure, extension may take place by elastic and viscous deformation of the fibers and the bonds. In the case of the higher molecular weight compounds which, because of fiber penetration difficulties, probably cause a decrease in bonding strength with relatively little effect on fiber properties, this weakening effect is evidently sufficient to cause failure at a relatively low extension. The smaller molecules, however, undoubtedly have greater swelling and penetrating powers than the large hydrophobic molecules, and thus exert a greater effect on the fibers themselves. It is probably this fact which accounts for their ability to increase stretch.

Comparison of the Plasticizing Efficiencies of the Compounds on the Various Properties

By way of summarizing the foregoing discussion and emphasizing the most important results of the work, the plasticizing efficiencies of all the compounds studied have been compared for the various properties in Figs. 8 and 9.

It is obvious from the nature of the curves in Figs. 3 to 7 that it is difficult to assign an average efficiency value to the various compounds since the slopes of the curves generally change with increasing additive concentration. In order to compare efficiencies on a uniform basis, the percentage reduction in the property at 100 millimoles of additive was taken as a measure of the efficiency of the compound in reducing the particular property. Where the study did not include concentrations as high as 100 millimoles, or where the additive's effect dropped off at a lower additive content, the initial curve was extrapolated to 100 millimoles and the extrapolated value taken.

Figure 8 for tensile strength and Fig. 9 for final slope show the most marked increase in additive efficiency with increasing molecular weight. This is believed to be because these two properties are more sensitive to changes in bonding strength than the other properties. Although increasing molecular size tends to increase the difficulty with which the compound penetrates the fiber structure, it is presumed that even the largest compounds are capable of penetrating the more easily accessible bonded regions. For this reason, penetration difficulties do not appreciably limit the effect of increasing molecular size for those properties which are especially sensitive to changes in bonding strength.

In connection with the effect of molecular size, it is interesting to note that, for both tensile strength (Fig. 8) and final slope (Fig. 9), the symmetrically substituted

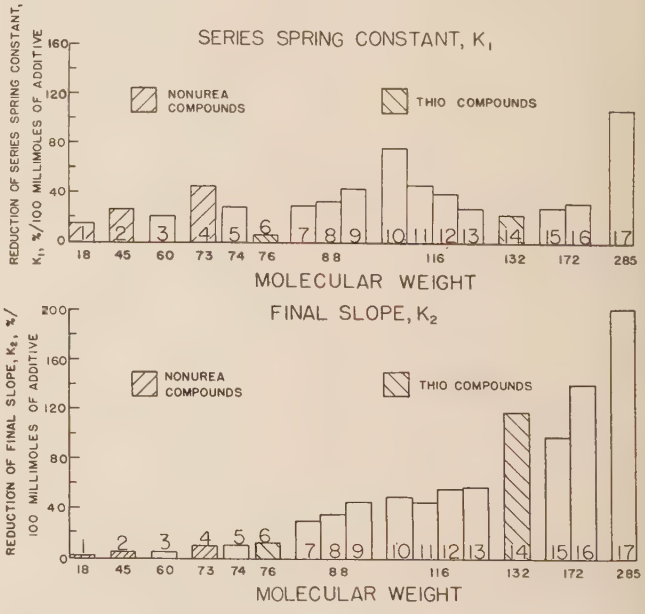
SERIES SPRING CONSTANT, K1
REDUCTION OF SERIES SPRING CONSTANT, K1, %/100 MILLIMOLES OF ADDITIVE
NONUREA COMPOUNDS
THIO COMPOUNDS
MOLECULAR WEIGHT
FINAL SLOPE, K2
REDUCTION OF FINAL SLOPE, K2, %/ 100 MILLIMOLES OF ADDITIVE
MOLECULAR WEIGHT

Fig. 9. Comparison of the efficiencies of the various compounds in reducing the series spring constant, K_1, and the final slope, K_2, respectively

1. Water
2. Formamide
3. Urea
4. Dimethylformamide
5. Methylurea
6. Thiourea
7. 1,1-Dimethylurea
8. 1,3-Dimethylurea
9. Ethylurea
10. Tetramethylurea
11. 1,1-Diethylurea
12. 1,3-Diethylurea
13. Butylurea
14. 1,3-Diethylthiourea
15. 1,1-Dibutylurea
16. 1,3-Dibutylurea
17. Tetrabutylurea

compounds were more effective than their unsymmetrically substituted isomers. Crystalline density data for the dimethylureas (*41*) indicate that the symmetrically disubstituted ureas have a greater molecular volume

than do the unsymmetrically disubstituted ureas. This, then, may be taken as a secondary indication that the molecular volume of the additive molecule is important in its ability to weaken secondary bonding forces by maintaining a greater degree of dry swelling.

Figure 9 for the f value and the series spring constant K_1, respectively, shows the effect of increasing molecular size to a lesser degree than Fig. 8 for tensile strength and final slope. If the tetrabutylurea value is neglected, it would seem that an optimum molecular weight range exists for the efficiency of the additive in reducing these properties. This is believed to indicate that the ability of a plasticizer to penetrate the fibers is of importance in the reduction of these values. The effect of molecular size is the least evident in Fig. 9 for the series spring constant. The fact that the formamides, which have strong swelling powers, are more effective than would be expected on the basis of their molecular weights is believed to further indicate the importance of swelling and penetrating ability to the K_1-reducing ability of an additive. Likewise, the thio compounds, which theory would predict would be weaker hydrogen bonding agents than the corresponding oxygen compounds, are less effective than the normal ureas of similar molecular weight. It would seem that their poorer bonding ability may result in a relative inability to penetrate the fiber structure.

The comparison of the effect of the various amides on the sheet properties just discussed, as well as the data presented in section B of Table II, indicates that the mechanical properties considered in this paper fall into three general categories. The properties in the first group—tensile strength and final slope (K_2)—are relatively insensitive to changes in the fiber but are quite dependent on the strength of the fiber-to-fiber bonds. They are, therefore, less affected by the relative swelling and penetrating abilities of the plasticizer molecule. The second group includes the flow properties, of which the f value is an example. These properties seem to be intermediate in their dependence on inter- and intra-fiber bonding. The third group—comprising the series spring constant (K_1) and the initial slope—seem to be more sensitive to the fiber swelling and fiber penetrating powers of an additive.

THE MECHANISM OF PLASTICIZING WITH UREA

On the basis of the data obtained in this work, which of necessity have been rather sketchily discussed in the foregoing sections, it seems possible to present a reasonable picture of the mechanism of the plasticizing of paper with the ureas. Although it is believed that other plasticizers may act in the same way as the ureas, any extension of the mechanism to other plasticizers must remain purely speculative.

Chronologically, the action of a urea plasticizer may be divided into its effect during the drying of a sheet of paper and its effect during the later mechanical stressing of the sheet. The role of the plasticizer is probably much the same in both cases.

When a sheet of paper is soaked in water or an aqueous solution of a plasticizer, the fiber-to-fiber bonds and the amorphous regions of the fibers undergo swelling. It is very likely that this swelling action disrupts some of the intermolecular bonds which are responsible for fiber strength and bonding strength, so that, when a water-soaked sheet is redried, some of the bonds fail to reform. The swelling power of the solution probably influences the extent to which this disruption process proceeds. The bonded zones are probably more readily swollen than the amorphous regions of the fibers and, hence, are probably more seriously weakened by soaking in a swelling agent than the intrafiber bonding forces.

As water is removed from the sheet on drying, the urea plasticizer molecules are believed to form hydrogen bonds with cellulosic hydroxyl groups through their carbonyl group, thereby anchoring themselves throughout the amorphous portions of the fiber structure and the bonded areas, and effectively satisfying some of the residual valence forces of the cellulose so that they no longer attract hygroscopic moisture.

By their presence throughout the amorphous regions of the cellulosic structure, the plasticizer molecules force the cellulose to retain a higher degree of swelling at a given water content than would normally be the case. This reduces the number and the strength of intermolecular cellulose bonds, with the result that the shrinkage of individual fibers is lessened and the ability of the fiber-to-fiber bonds to transmit shrinkage stresses is impaired. Shrinkage tension and frozen-in stresses are thereby reduced.

To summarize, a dry plasticized sheet is different from a dry unplasticized sheet in at least three respects: (a) the fiber structure and the bonded areas of the plasticized sheet are forced to retain some greater measure of dry swelling than would normally be the case, with the result that their internal bonding strength is reduced and the rigidity of the whole structure is lessened; (b) the extent to which drying tension and frozen-in stresses have stiffened and strengthened the sheet is less in the plasticized sheet; and (c) some of the residual secondary forces of the cellulose have been satisfied by bonding with the plasticizer so that they do not attract and hold the usual number of water molecules.

The state of dry swelling in a plasticized sheet markedly affects the load-elongation properties of the dry sheet. The total fiber-to-fiber bonding strength is probably reduced by a plasticizer in one of three ways: (1) the plasticizer molecule "covers" reactive hydroxyl groups which would normally form intermolecular bonds, thus reducing the number of individual bonds; (2) the number of intermolecular bonds is still further reduced because, in the immediate neighborhood of a plasticizer molecule, the cellulose chains are separated by a distance which is greater than the maximum bonding distance; and (3) the bonds which do form in spite of the presence of a plasticizer are weakened because of the greater bonding distances involved. Since molar plasticizing effect on the bonds was found to be a strong function of the plasticizer's molecular size, it must be concluded that the total fiber-to-fiber bond weakening action is primarily due to (2) and (3) rather than (1).

The internal cohesive forces in a fiber are probably reduced by a plasticizer in much the same way as that just postulated for the fiber-to-fiber bonds. In the case of the fibers, however, the effect of plasticizing is probably lessened by penetration difficulties and by the limitations placed on swelling by the crystalline

regions. The greater disorder in the bonded zones undoubtedly makes them more easily accessible to plasticizer molecules. Thus, a large portion of the plasticizing effect results from changes in the fiber-to-fiber bonding strength.

The reduction of fiber-to-fiber bonding strength and internal bonding strength of the fibers naturally brings about a reduction in tensile strength and elastic properties. The reduction in secondary bonding forces resulting from the state of dry swelling also frees the molecular or macromolecular flow units of some of their restrictions and enhances their ability to flow past one another. If the effect of the reduction of fiber-to-fiber bonding strength does not exceed the effect of freeing these flow units, the extensibility of the paper will probably be increased.

With the above discussion as a background, it seems possible to list some of the properties which are instrumental in determining the relative effectiveness of a material as a plasticizer for paper. These are:

(1) *The ability to permeate the amorphous regions of the cellulose structure, including the bonded areas.* In order to exert an effect on the fibers and the fiber-to-fiber bonds, a material must be able to penetrate these portions of the sheet. Since water has swelling properties, a plasticizer applied from aqueous solution probably does not need to have swelling properties of its own, although it must be able to take advantage of the water-swollen state to enter into the vital regions of the sheet. Penetration difficulties probably increase with increasing substitution since the polarity of the molecule is reduced as its molecular size is increased.

(2) *The ability to bond to the cellulose.* Some functional group capable of forming a bond with the cellulose is necessary in order to anchor the molecule in the cellulose structure. Reduction of the molecule's ability to bond to cellulose places it in a poor competitive position with water and probably hampers its ability to hold the cellulose structure open. Complete elimination of cellulose-bonding powers leaves the additive molecules free to form bonds between themselves and thus to crystallize wherever they may be left in the sheet. It is probable that the polar group which is responsible for the cellulose-bonding ability of the plasticizer molecule is also important in the ability of the compound to penetrate the fibrous structure.

(3) *The ability to maintain a state of dry swelling by mechanical separation of the cellulose molecules.* If the molecule has adequate penetrating ability and cellulose-bonding powers, this third factor determines its plasticizing efficiency. Increasing molecular volume, by higher substitution or by the substitution of larger groups, was found to greatly enhance the plasticizing ability of the ureas because of the increased ability of the larger molecules to keep the cellulose molecules from cross linking.

It is seen, then, that plasticizing is essentially a weakening action in which the number and the strength of the secondary bonding forces—those forces which are largely responsible for the mechanical characteristics of the fibers and the bonds—are reduced. This concept of the plasticizing of paper is fundamentally the same as the concepts advanced for the plasticizing of other high polymeric systems (*7–10, 12, 42*).

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The author is greatly indebted to Sharples Chemicals, Inc., for supplying many of the substituted ureas used in this work.

PERSONAL MENTION

Items About New and Old Tappimen

New TAPPI Members

Edward V. Alderson, Sales Representative, Heppenstall Co., Boston, Mass., a 1929 graduate of Pennsylvania State College.

Oscar L. Allanson, Development Engineer, Ohio Brass Co., Barberton, Ohio, a 1948 graduate of Purdue University.

Denton Anderson, Executive Vice-President, Snyder Chemical Corp., Bethel, Conn., a 1936 graduate of the University of Wisconsin.

Ellis T. Anderson, Plant Superintendent, Fulton Bag & Cotton Mills, New Orleans, La.

Velden M. Anderson, Mill Manager, Fir-Tex Insulating Board Co., St. Helens, Ore.

Anthis F. Austin, Student, The Institute of Paper Chemistry, Appleton, Wis., a 1950 graduate of The Rice Institute.

David W. Baird, Product Development, Johns-Manville Research Center, Manville, N. J., a 1949 graduate of the New York State College of Forestry.

William T. Bennett, Mechanical Engineer, P. H. Glatfelter Co., Spring Grove, Pa., a 1948 graduate of the University of Virginia.

Stuart I. Bergman, Technical Associate, The Institute of Paper Chemistry, Appleton, Wis., a 1948 graduate of The New York State College of Forestry.

Ramesh P. Bhargava, Manager, Star Paper Mills Ltd., Saharnpur, India, a 1939 graduate of Allahabad University.

Robert C. Brinkley, Manager-Owner, Steel Service & Supply Co., Seattle, Wash. Attended Harvard University.

Peter Calott, Chemical Engineer, American Cyanamid Co., New York, N. Y., a 1948 graduate of the University of Maine.

Flavio Cattani, President, Trenton Paper Corp., Trenton, N. J.

John E. Dain, Division Sales Manager, Cameron Machine Co., Brooklyn, N. Y.

James H. DeGroff, Technical Service Representative, Buckman Laboratories, Inc., Memphis, Tenn., a 1950 graduate of the Case Institute of Technology.

Walter S. Dempsey, Plant Manager, Doeskin Products, Inc., Wheelwright, Mass.

Malcolm G. Edwards, Pulp Mill Engineer, Gulf States Paper Corp., Tuscaloosa, Ala., a 1939 graduate of the Alabama Polytechnic Institute.

Norman C. Fairhead, Chemist, Bromptom Pulp & Paper Co. Ltd., Red Rock, Ont., Canada, a 1949 graduate of the University of British Columbia.

Eduard Farber, Chief Chemist and Consultant, Timber Engineering Co., Washington, D. C., a 1916 graduate of the University of Leipzig, Germany.

Taro Fuchida, President, Sanko Paper Mills Co. Ltd., Osaka City, Japan, a 1910 graduate of Kobe Commercial College.

Francis B. Gallagher, Student, The New York State College of Forestry, Syracuse, N. Y.

C. Westcott Gallup, Jr., Sales Engineer, R. T. Vanderbilt Co., Inc., New York, N. Y. Attended St. Johns College, Annapolis.

Jules Gilbert, Chemical Engineer, Westvaco Chemical Division, New York, N. Y., a 1941 graduate of the University of Wisconsin.

George B. Gregg, Power Engineer, Cincinnati Gas & Electric Co., Cincinnati, Ohio, a 1930 graduate of the University of Illinois.

Jose-Carlos A. N. Guerrero, Technical Director, Tableros de Fibras, S. A., Valladolid, Spain, a 1946 graduate of Madrid University with a D. es Sc. degree.

Heinz Haas, Leader of Pulp and Paper Group, Zellstofffabrik Waldhof, Mannheim-Waldhof, Germany, a 1933 graduate of the University of Munich and Freiburg with a Ph.D. degree.

Ludwig Hanselmann, Mill Manager, Westfalische Zellestoff A-S. Alphalint, Oeventrop, Westfalia, Wildshausen, Germany, a 1933 graduate of the Technical University.

Herbert R. Helbig, Jr., Manager, Central Atlantic Div., Reichhold Chemicals, Inc., Charlotte, N. C., a 1940 graduate of Michigan State College.

Joseph P. Kesling, Technical Service Dept., Innis Speiden & Co., New York, N. Y., a 1930 graduate of the Case School of Applied Science.

W. Oliver Kincannon, Jr., Chemical Engineer, W. C. Hamilton & Sons, Miquon, Pa., a 1950 graduate of the Massachusetts Institute of Technology.

Robert W. LaBerge, Chemist, E. I. du Pont de Nemours & Co., Inc., Philadelphia, Pa., a 1939 graduate of Lawrence College, with an M.S. degree from Michigan State College in 1948.

Guillaume C. Lardy, Technical Director of Acetate Spinning Plant, Societe Rhodiaceta, Lyon, France, a 1921 graduate of Polytechnic Federal College, Zurich, with a D.S. degree in 1923.

Gilbert Lescop, Technical Manager, Papeteries du Bourray, St. Mars-LaBriere, Sarthe, France, a 1942 graduate of Central College of Arts and Manufacturing.

Irving E. Lightbown, Market Development Manager, Enjay Co., Inc., New York, N. Y., a 1931 graduate of Cornell University.

Daniel E. Lucas, Chemist, Corn Products Refining Co., Argo, Ill., a 1947 graduate of St. Mary's College, Winona, Minn.

George W. Mead, II, Student, The Institute of Paper Chemistry, Appleton, Wis., a 1950 graduate of Yale University.

Pehr-Gustaf Michelsson, Assistant to Manager of Technical Dept., Kymin Osakeyhtio-Kymmene Aktiebolag, Kuusankoski, Finland, a 1945 graduate of the Technical University, Helsinki.

Walter Mikelson, Industrial Engineer, General Electric Co., Schenectady, N. Y., a 1934 graduate of the University of Michigan.

Atsushi Nakanishi, Chief, Research Laboratory of Government Printing Agency, Tokyo, Japan, a 1928 graduate of Tokyo Imperial University.

Arthur J. Norton, Consulting Chemist, Seattle, Wash., a 1920 graduate of Harvard University.

Maskazu Ohyama, Chief of Engineering Dept., The Kokusaku Pulp Industry Co. Ltd., Tokyo, Japan, a graduate of Tokyo Technical College.

Frank T. Osika, Chemist, E. I. du Pont de Nemours & Co., Inc., Rochester, N. Y., a 1948 graduate of the Brigham Young University.

Richard E. Pentoney, Graduate Student, the New York State College of Forestry, Syracuse, N. Y., a 1949 graduate of the University of California.

Donald F. Pohlman, Assistant to Chief Steam and Power Development Engineer, Scott Paper Co., Chester, Pa., a 1947 graduate of the University of Michigan.

Thomas Punshon, Jr., Manager of Laboratories, J. M. Huber Corp., Brooklyn, N. Y., a 1937 graduate of Bucknell University.

Hans Sachsse, Mill Manager, Zellstofffabrik Waldhof, Wiesbaden, Germany, a 1931 graduate of the Universitat with a Ph.D. degree in 1935.

Albert A. Schilling, Chemist, Remington Arms Co., Inc., Bridgeport, Conn., a 1928 graduate of New York University.

Lewis Simon, Chief Research Officer, Forest Research Institute, Dehra Dun, U. P., India, a 1922 graduate of the University for Technical Sciences, Budapest, with an M.Sc. degree.

Michel Sirvin, Student, New York State College of Forestry, Syracuse, N. Y., a graduate of Paris University.

Walter T. Smith, Sales, Southern Clays, Inc., New York, N. Y., a 1935 graduate of the University of Alabama, with an M.S. degree.

Alan K. Soper, Research Chemist, Kodak Ltd., Wealdstone, Middlesex, England, a 1933 graduate of the University of Wales, with an M.Sc. degree from the University of Manchester.

Walter W. Stickland, Pulp Mill Chemist, Champion-International Co., Lawrence, Mass., a 1939 graduate of Northeastern University.

Royal A. Stone, Engineer, Rayonier, Inc., New York, N. Y., a 1933 graduate of the Massachusetts Institute of Technology.

Lauri J. Tiilikka, Resident Manager, United Paper Mills Ltd., Jamsankoski, Finland, a 1927 graduate of the Technical University, Finland.

Wyman F. Uhl, Student, Western Michigan College, Kalamazoo, Mich.

Carl-Gustaf von Essen, Chief Engineer, Dynas A. B., Vaja, Sweden, a 1934 graduate of Chalmers Technical University.

Archibald Welch, General Manager and Director, The E. B. Eddy Co., Hull, P. Q., Canada, a 1936 graduate of Niagara University.

Theodore O. Wentworth, President, The Vulcan Copper & Supply Co., Cincinnati, Ohio, a 1929 graduate of the Massachusetts Institute of Technology.

Fred A. Weymouth, Vice-President, International Printing Ink Div., Interchemical Corp., New York, N. Y. Attended the University of Cincinnati, and the University of Miami, Oxford, Ohio.

G. Gordon White, Sales-Technician, A. E. Staley Mfg. Co., Decatur, Ill., a 1946 graduate of Brown University.

Robert C. Whitney, Student, the New York State College of Forestry, Syracuse, N. Y.

Charles M. Woodcock, Jr., Project Leader, General Foods Corp., Central Laboratories, Hoboken, N. J., a 1942 graduate of the University of Massachusetts, with an M.S. degree from Ohio State University in 1947.

John H. Wrightsman, Technical Representative, A. E. Staley Mfg. Co., Decatur, Ill.

Frank L. Yankoviak, Student, Western Michigan College, Kalamazoo, Mich.

TAPPI Notes

Arthur Baker is now Director of The Bowater Paper Corp. Ltd., London, England.

Lee M. Bauer is now Assistant Treasurer of the Ecusta Paper Corp., Pisgah Forest, N. C.

Wallace W. Brown, formerly of Consolidated Paper Co., is now Technical Supervisor, Howe Sound Pulp Co., Ltd., Port Mellon, B. C.

Ellis A. Enridge, formerly of G. S. Eldridge Co., is now Chemical Engineer for Columbia Cellulose Co., Ltd., Prince Rupert, B. C.

John R. Fielding, formerly of the H. K. Ferguson Co., is now Project Engineer, Union Bag & Paper Corp., Savannah, Ga.

Frederick H. Gayer, formerly of the Continental Research Corp., is now Consulting Chemist, 1223 E. 57th Street, Chicago 37, Ill.

E. Norval Hunter is now Vice-President of the Kalamazoo Vegetable Parchment Co. Mr. Hunter is located at Española, Ont.

Yun Jen, formerly of the New York State College of Forestry is now in the Research Laboratory of the American Cyanamid Co., Stamford, Conn.

A. C. Jung is now Manager, Primary Bulk Products Dept., Clinton Foods, Inc., Clinton, Iowa.

Glengarry D. King is now Assistant to the Superintendent, Crown Zellerbach Corp., West Linn, Ore.

Lloyd L. Klinger is now Project Engineer, Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis.

Earl O. Knapp of the Weston Paper & Mfg. Co. has been transferred from St. Marys, Ohio, to Terre Haute, Ind.

Robert L. Leaf, Jr., is now Resident Manager of the Little Rapids Pulp Co., De Pere, Wis.

Robert J. Proctor, formerly of the Fitchburg Paper Co., is now Assistant General Manager of the West Jersey Paper Mfg. Co., Camden, N. J.

Homer St. Clair is now Chemist for the French Paper Co., Niles, Mich.

Hervey J. Skinner has retired from Skinner & Sherman, Inc., Boston, Mass. Mr. Skinner has been a consultant for over 40 years. Following 17 years with Arthur D. Little, Inc., he organized the firm of Skinner, Sherman & Esselen, Inc. in 1921.

Harry M. Sutcliffe, formerly of the Northern Regional Research Laboratory, is now Chemist for the Celotex Corp., Marrero, La.

D. A. Washburn, formerly of the Plastic Fibre Corp., is now General Manager, New London Mills Inc., New London, Conn.

* * *

R. I. Wynn-Roberts, Chief Engineer of Finch, Pruyn & Co., Glens Falls, N. Y., has succeeded H. F. Bullard (deceased) as the official corporate representative of the Company in the Technical Association.

* * *

A. L. Burton has succeeded A. P. Schreiber as the official representative of Tracerlab, Inc., Boston, Mass., in TAPPI.

W. S. Corneille has succeeded E. D. Ogle as the official representative of SKF Industries, Inc., Philadelphia, Pa., in TAPPI.

Industry Notes

John W. Hanes has been elected President and Chairman of the Board of the Ecusta Paper Corp., Pisgah Forest, N. C.

* * *

American Key Products, Inc. has moved its offices from 15 Park Row to 270 Madison Ave., New York 16, N. Y.

* * *

Thorsen Products Corp. has moved its offices to the Woolworth Bldg., 233 Broadway, New York 7, N. Y.

* * *

Texon, Inc., South Hadley Falls, Mass., has expanded its research and development activities and has added Edward O. Denzler and Frank Hill to its staff. Mr. Denzler was formerly with Acushnet in New Bedford, Mass., and Mr. Hill was with the Union Bag & Paper Corp. at Hudson Falls, N. Y.

* * *

The Pittsburgh Plate Glass Co. has purchased the 49% interest of the American Cyanamid Co. in Southern Alkali Co. The purchase price was about 19 million dollars.

ALL-OUT PRODUCTION

demands

BIG, MODERN BIRD SCREENS

—Screens that have the capacity to deliver all of the fibres that the paper machine can take—and the ability to deliver them clean, well combed, thoroughly individualized, uniform in weight, free of lumps, strings and slime.

Make certain that your paper screening operation is capable of meeting the responsibility for all-out production.

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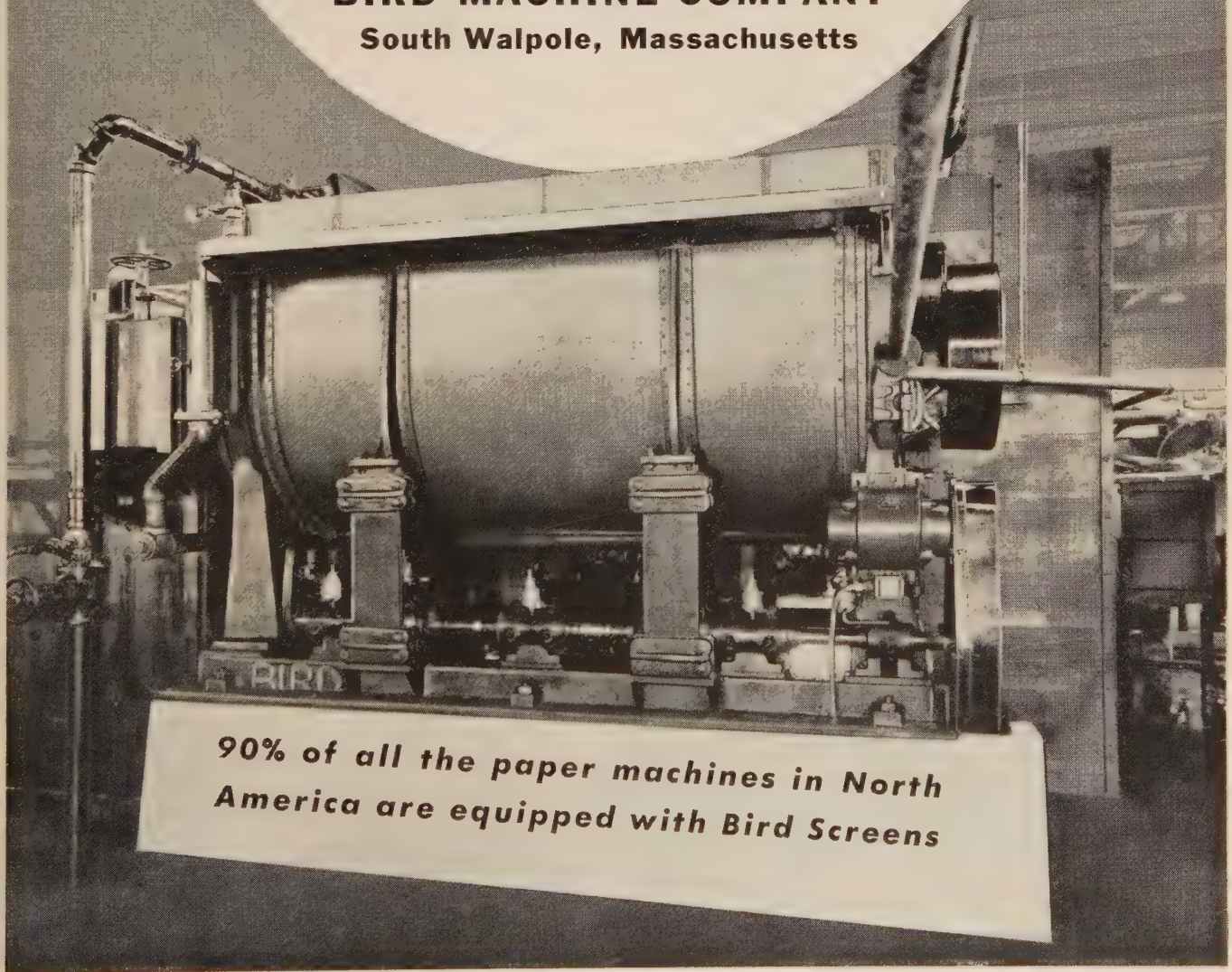
South Walpole, Massachusetts



90% of all the paper machines in North America are equipped with Bird Screens

Paul W. Leppla, Associate Director of Research at the Morton Grove, Ill., research laboratory of Great Lakes Carbon Corp., has been appointed Technical Director of the Corporation's Dicalite Division, with headquarters in Los Angeles.

* * *

Charles A. Thomas has been elected President of the Monsanto Chemical Co., succeeding William R. Rand who is retiring. He has been Executive Vice-President since 1947, going with Monsanto when it acquired the General Motors Research Laboratories in Dayton, Ohio, in 1936. He is one of the nations leading atomic scientists.

* * *

The Great Northern Paper Co. plans to build a 6 million dollar hydroelectric project at its Ripogenus Dam on the Penobscot River. Stone & Webster is doing the preliminary engineering work. Two years will be required for the project.

* * *

The Engineering Manpower Commission of Engineers Joint Council has summed up the shortage of engineers problem. The mortality rate in engineering schools is high (50%). To get 30,000 engineers, 60,000 need to be enrolled as freshmen. High school graduations are declining and 10% of the male high school graduates would have to take engineering studies to meet a 60,000 freshman college enrollment. (Only 3% of all high school graduates go to college.) The country will be short 40,000 engineers by 1954.

* * *

In ordinary times 2500–3000 graduating chemical engineers find employment in industry. Last June 4300 graduates found employment. About 3200 are graduating this June; 2200 in 1953 and the current freshman class will supply only 1800–2000 in 1954. (These figures do not take into account draft losses.)

* * *

A new engineering service for white water clarification and stream purification has been announced by Robert A. Baum, Manager of the Engineering Division of Bulkley, Dunton Pulp Co. The service features the Colloidair Saveall, a new and improved flotation system, for application in white water recovery, treatment of total mill effluent, and also in connection with Bulkley, Dunton's new developments in totally closed systems.

The new improvements, for which patents are pending, and the flotation unit will bear the name Colloidair Separator. In order to effectively meet the needs of the paper industry, new offices and personnel have been established throughout the United States. Requests for information should be sent to Robert A. Baum, Bulkley, Dunton Pulp Co., 295 Madison Avenue, New York, N. Y.

* * *

Sweden has increased its export taxes on pulp and paper to $14.50 per ton for mechanical pulp, $39 for chemical pulp, $39 for newsprint, and $42.50 for cardboard and paper other than newsprint. A further increase is expected in August. This price-equalization tax on exports of forest products became effective on Jan. 1, 1951. It was established by the Swedish government to maintain economic stability and to retard inflationary effects of international price movements on the internal Swedish price structure. All funds collected are deposited in special blocked accounts in the National Debt Office. Seventy per cent of the funds collected is to be returned to industry over a 5-year period beginning in 1958, unless business conditions warrant repayment before that time. The remaining 30% is divided among employees, social and welfare foundations, and a fund set up to promote better care of privately owned forests.

A similar agreement between the government of Norway and the pulp and paper industry has been reached. In the second quarter the export duty for rayon pulp was raised to $29.40 per metric ton; for chemical wood pulp to $29.20; and for newsprint the increase has been to $29.40. Forty per cent of the proceeds from the duties is used to subsidize other prices, 40% for a fund for the wood processing industry and 20% for a fund for rationalization of the forest industry.

* * *

According to *Foreign Commerce Weekly* paper and paper materials ranked third among imports (valued at $746 million) in 1950, an advance of 12% over 1949. Coffee ($1,091,000,000) and nonferrous ores, metals, and ferroalloys ($867,000,000) were the only two groups showing a greater value of imports last year.

* * *

The National Production Authority and the Defense Production Administration established an Inquiry Center on May 1 in the G.A.O. Building, Fifth and G Streets, N. W., Washington, D. C. This is to aid business representatives who visit Washington; a complete file of orders, regulations, forms, publications, and similar material of defense agencies will be maintained here. Stationed near the reception desk will be a staff of industry specialists who will supply information on specialized problems.

* * *

The Office of International Trade has set a second quarter export quota of 250,000 long tons of sulphur. The total crude sulphur available for export licensing in the first 6 months of 1951 is now fixed at 480,000 long tons, a 14% decrease over the first 6 months of 1950.

* * *

Pulp manufacturers in Wisconsin are going ahead with a cooperative research program to reclaim sulphur from spent sulphite liquor.

Rhinelander Paper Co. strips sulphur dioxide from spent sulphite liquor before putting the liquor through its yeast plant to reduce pollution by making a vitamin supplement for feed. Reclaimed sulphur dioxide is reused in the pulp mill. This saving is sufficient to make 4 tons of pulp daily.

The Interlake mill of Consolidated Water Power & Paper Co. is currently completing a system to catch sulphur dioxide which otherwise would escape in the steam and spent liquor when the digesters are emptied. This saving will account for a daily increase in pulp production of 10 tons.

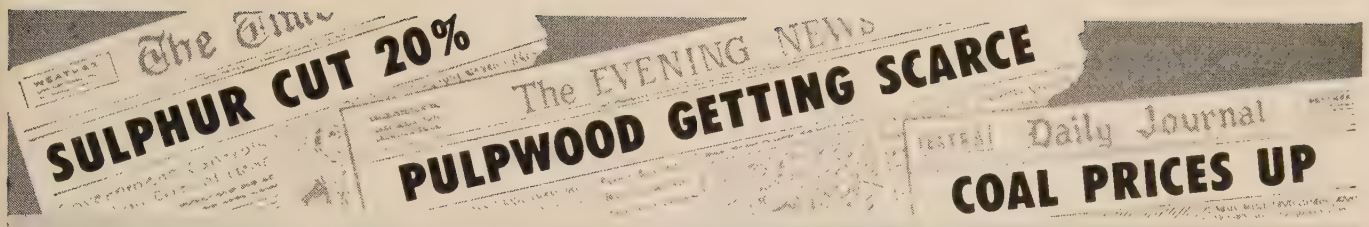
The Chairman of the Sulphur Research Committee of the Sulphite Pulp Manufacturers Research League is T. A. Pascoe, Nekoosa Edwards Paper Co., Associated with him are Gilbert Dickerman, Consolidated Water Power & Paper Co., and Horace A. Du Bois, Kimberly-Clark Corp.

* * *

Most roads in Sweden are now treated with sulphite waste liquor road binder. In Wisconsin the mileage of road covering is increasing. The cost of sulphite binder within 100 miles of a sulphite mill is much lower than for any comparable treatment. In Outagamie Country, Wis., a country truck gravel road received treatments last fall, one side of the road was left untreated for 300 feet. The treated road for all 6 miles came through the winter, smooth and hard. The untreated 300-foot test section showed deep ruts by late March, and remained soft and deeply rutted even after new gravel had been added.

* * *

In 1950 the Wisconsin mills spent $1,133,000 to reduce stream pollution, and in 1951 expect to spend several times this much. Pollution experts agree that the pulp and paper mills, for many years, have spent more money and effort than



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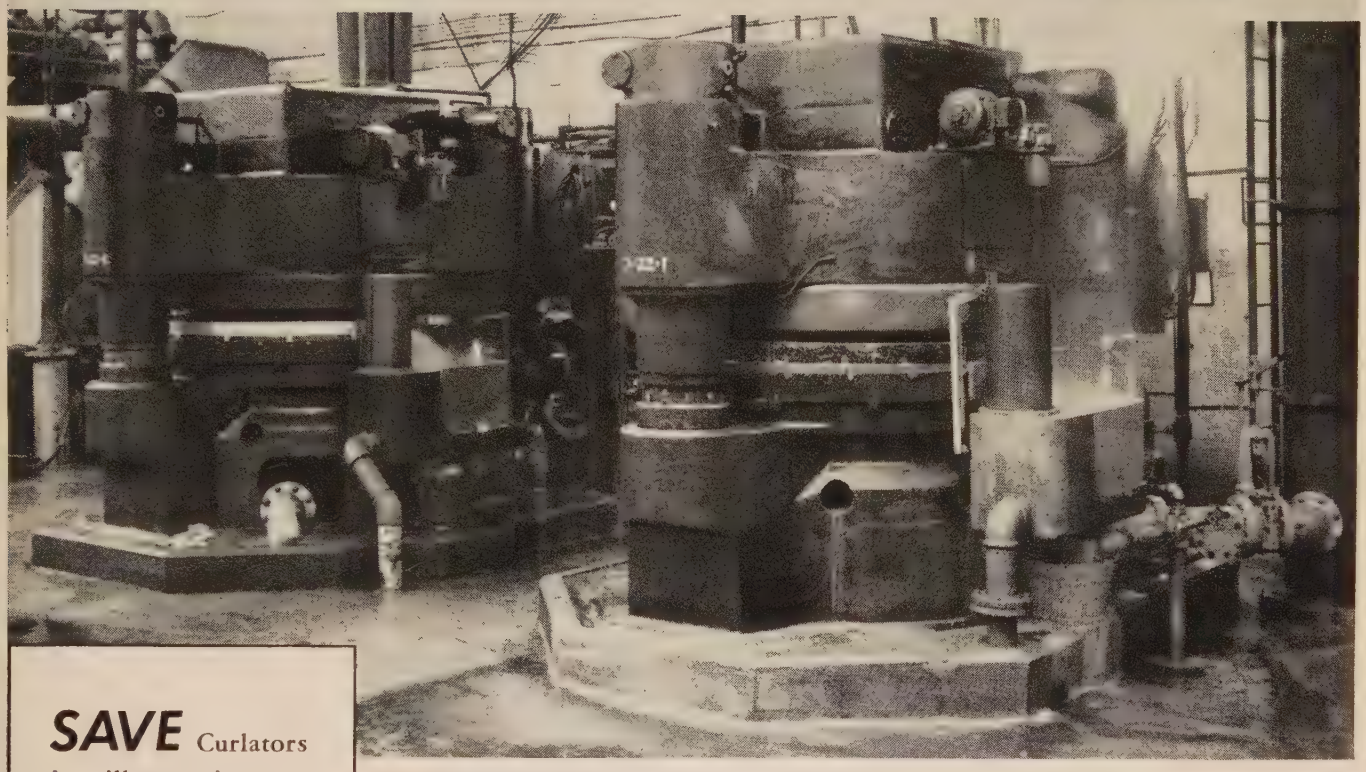
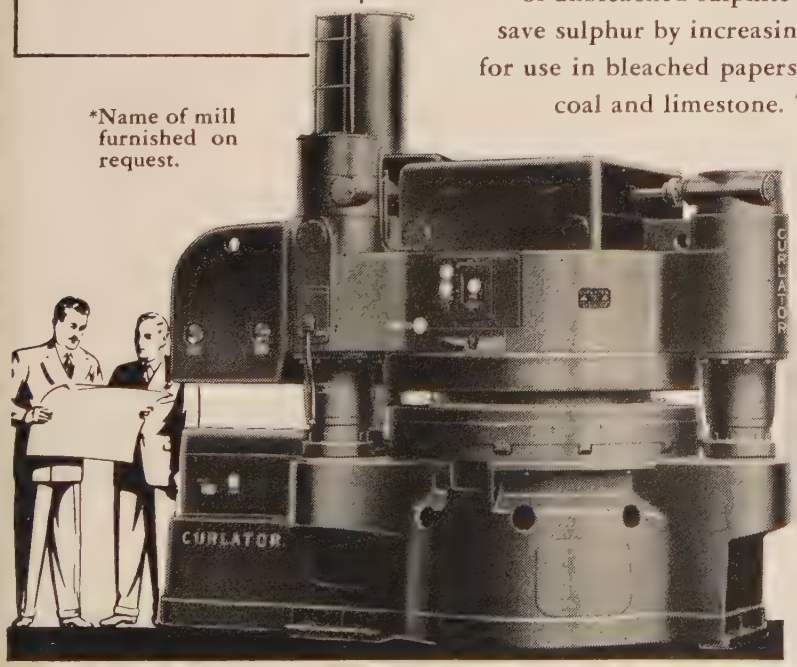


SAVE Curlators in mill operations are making substantial savings in sulphur, pulpwood, coal, and limestone.

These CURLATORS are saving this mill* more than 10% of sulphur, pulpwood, coal and limestone.

By *Curlation* you too may save 10% of your sulphur in the manufacture of unbleached sulphite for use in unbleached papers. You can also save sulphur by increasing the net yield, of unbleached sulphite pulp for use in bleached papers. In addition *Curlation* will save pulpwood, coal and limestone. These savings will not only lower costs but help conserve scarce materials.

*Name of mill furnished on request.



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any other industry in Wisconsin to reduce stream pollution. They have succeeded so well that today spent sulphite liquor is practically the only significant type of pollution which the mills still flow into the streams. There are fifteen sulphite mills in the state. The mills are using spent liquor as a road binder on unpaved roads. The mills are testing ways to evaporate it and burn it as a fuel. Three of these mills now are building complete evaporate-and-burn plants. Four mills are testing the ammonium base method of sulphite pulping. Two are making by-products to remove pollutional effects from their liquor.

* * *

A comprehensive reinventory of the forests and forest industries of Alabama began on May 7. The survey is being made by the Southern Forest Experiment Station in cooperation with the Alabama Department of Conservation. Guided by aerial photographs five 2-man timber cruising teams measured the trees on quarter-acre plots at 3-mile intervals throughout the State. On each plot they identify three "witness trees," so that the plot can be located and remeasured in future surveys. This is a new procedure that is expected to give very accurate information on tree growth. The survey will include studies of the amount and kind of wood used by industries and of the rate at which wood is being used. In recent years Alabama has led the South in lumber production.

* * *

The OPS allowed Finnish pulp importers to increase their prices for pulp imported into the United States for the second quarter of 1951. Prices now are: bleached sulphite, $225; unbleached sulphite, $200; unbleached kraft, $200; and groundwood, $125.

* * *

George W. Marshall, Jr., and Alvin F. Heinsohm have been elected Vice-Presidents of Raybestos, Manhattan Inc., Passaic, N. J. The Company will erect a new plant at Crawfordsville, Ind., to be named the Wabash Division of the Company.

* * *

The Sveen Pedersen Sales Corporation, 35–41 11th Street, Long Island City 6, N. Y., has been appointed the exclusive Agent to sell, engineer, and service the Sveen Pedersen patented flotation saveall. This equipment will be known in the future as the Sveen Pedersen Flotation Separator.

The patented separator, which has been in use in the United States since 1938, has proved very successful in reclaiming or separation of suspended solids, in white or waste waters. This equipment, while primarily used in conjunction with paper machines can be used to separate any type of suspended matter from water.

The Wegner Machinery Corporation will continue to manufacture the equipment. This arrangement will expedite and simplify both the manufacture of new equipment and the servicing of existing units.

* * *

The Second Annual Statistical Quality Control Institute of the University of Connecticut will be given at Storrs, Conn., from Aug. 5–7, 1951. The fee is $127, covering tuition, room, board, and educational supplies. Information may be obtained from R. M. Story, Jr., Coordinator, University of Connecticut, Storrs, Conn.

* * *

The Atlas Mineral Products Co., Mertztown, Pa., who pioneered the development of liquid neoprene coatings has now improved its product so that it is readily sprayed and is fast-curing at ordinary temperatures. The product Neobon is available in experimental quantities. The Company has announced a new coating called Alkaloy 550 which is resistant to all alkalies, solvents, salts, and many acids. This product is available as a high-solids liquid which is converted at the time of use to a jet black resilient solid. Products of this general type based on furfuryl alcohol have been known since 1940. The new coating is flexible, a property not heretofore attained in similar coating of the Alkor class.

* * *

Warren A. Beman has been appoined to direct the chemical products development for the Socony-Vacuum Oil Co., 26 Broadway, New York, N. Y. Mr. Beman will work closely with companies in the paper, textile, plastic, rubber, and chemical fields.

* * *

Alfred S. Sampsierre has been elected Vice-President in charge of manufacturing and engineering operations of Jackson & Church Co., Saginaw, Mich.

The General Electric Co., Schenectady, N. Y., has issued a new bulletin (GEA-5520) on Drives for Pulp Mills. This covers backers, saws, chippers, grinders, materials handling, washers, pumps, etc.

* * *

The Certified Pulp Testers Bureau, 122 East 42nd Street, New York 17, N. Y., has issued the following list of approved testers for 1951.

Commercial Laboratories

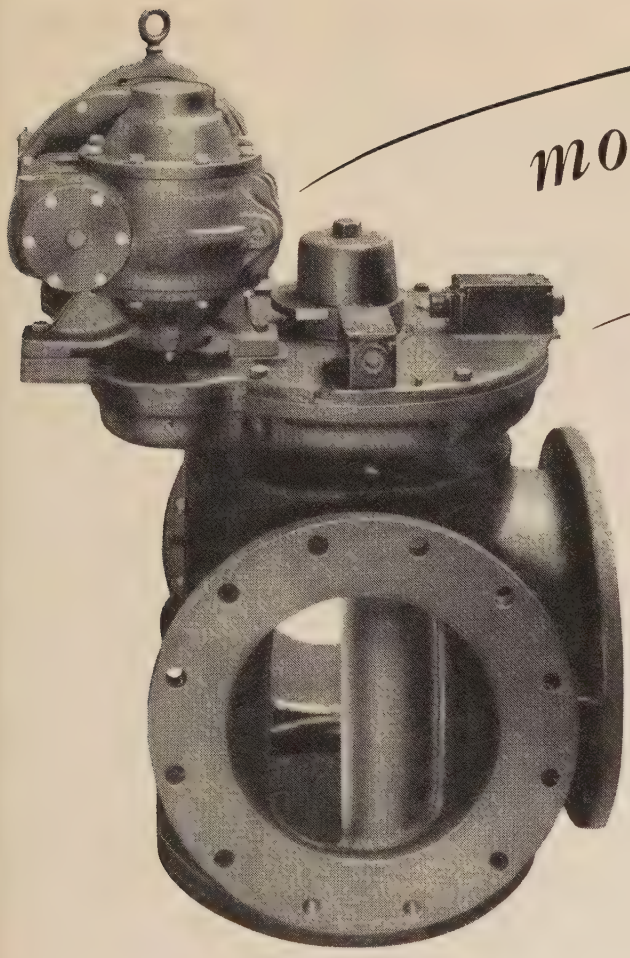
Andrews, A. B., Box 57, Lewiston, Me.
Danneker & Evans, Inc., 309 Camp St., New Orleans, La.
Donald & Co., J. T., Ltd., 1181 Guy St., Montreal, Canada.
Goodrich, Neil C., South Haven Terminal Co., Inc., 251 Center St., South Haven, Mich.
Gulick-Henderson Laboratories, 431 S. Dearborn St., Chicago 5, Ill.
Hamlin & Morrison, 216 S. 2nd St., Philadelphia, Pa.
Landes, William, Paper and Pulp Testing Laboratory, 118 E. 28th St., New York, N. Y.
Orthmann Laboratories, Inc., 922 N. 4th St., Milwaukee, Wis.
Paquin, Felix, Felix Paquin & Associates, Galveston, Tex.
Skinner & Sherman, Inc., 246 Stuart St., Boston, Mass.
Sutliff, John H., Font Grove Road, Slingerlands, N. Y.
U. S. Testing Co., Inc., 1416 Park Ave., Hoboken, N. J.
Whittington, E. F., 530 West Cedar St., Kalamazoo 45, Mich.
Wiley & Co., Inc., 904 N. Calvert St., Baltimore, Md.
Williams Apparatus Co., Inc., Herald Bldg., Watertown, N. Y.

Pulp and Paper Mill Laboratories

Adams, Henry R., Bloedell, Stewart & Welch, Ltd., Port Alberni, B. C., Canada.
Baker, D. H., H. R. MacMillan Export Co. Ltd., Pulp Div., P. O. Drawer 18, Nanaimo, B. C., Canada.
Bradford, Harry C., Rex Paper Co., Kalamazoo, Mich.
Butler, R. A., Pacific Mills, Ltd., Ocean Falls, B. C., Canada.
Clark, Clarence T., Restigouche Co. Ltd., Campbellton, N. B., Canada.
Enghouse, Clarence A., Crown Zellerbach Corp., West Linn, Ore.
Hartnagel, Nelson, Fibreboard Products, Inc., Port Angeles, Wash.
Jacoby, W. C., Crown Zellerbach Corp., Camas, Wash.
Jones, Franklin, St. Joe Paper Co., Port St. Joe, Fla.
Marriott, Robert R., Crown Zellerbach Corp., Port Townsend, Wash.
Tennent, G. R., Hummel-Ross Div., Continental Can Co., Hopewell, Va.
Thieme, R. I., Soundview Pulp Co., Everett, Wash.
Weleber, F. J., Publishers Paper Co., Oregon City, Ore.
Wood, Edward P., Hollingsworth and Whitney Co., Mobile 7, Ala.
Dr. D. L. Sherk, Columbia Cellulose Co. Ltd., Engineering Dept., P. O. Box 1000, Prince Rupert, B. C., Canada.

* * *

The Dilts Machine Co., Fulton, N. Y., has issued a four-page bulletin (6-DM) that illustrates ten waxers, board laminator, foil laminator, embosser, and the Kohler unwinder and flying poster.



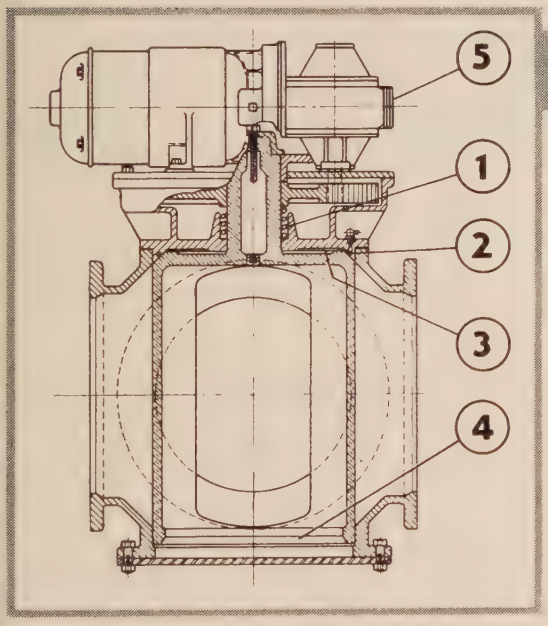
motorized rotary valves

Trouble common to older type rotary valves are eliminated by the Shartle improved design motorized rotary valve.

This versatile rotary valve is ideal for many "out-of reach" locations in the pulp or paper mill, and is especially adaptable to automatic systems with push buttons or automatic controls located at a central control station.

The Shartle rotary valve is flexible in that it can be installed in any position, and is available in designs to suit any paper mill requirement; whether it be for valving a single line or providing flow in any of four different directions from a single inlet.

Available in straight way, two, three, four, or five-way designs; size range from 4″ to 24″. Constructed of materials, or combinations of materials, to suit paper stock conditions.



DESIGN FEATURES

1. Spring loaded rotor held firmly in position—no rotor drag at bottom of valve.
2. Lubricated packing at sloping shoulders of rotor provides positive seal at all times.
3. No contaminated pockets. Seal prevents entrance of stock to this area thus preventing clogging or jamming of rotor.
4. Open bottom eliminates possibilities of stock accumulation under rotor, and provides stock entrance for bottom inlet type rotary valves.
5. Gearhead motor drive—through cut spur gear and pinion, provides for electric remote control of rotor.

SHARTLE BROTHERS MACHINE COMPANY,
MIDDLETOWN, OHIO

DILTS MACHINE WORKS, Fulton, New York
Divisions of THE BLACK-CLAWSON CO., Hamilton, Ohio
Western Sales Office: Mayer Bldg., Portland, Oregon
Southern Sales Office: 937 Coventry Road, Decatur, Georgia

Associate: THE ALEXANDER FLECK LTD., Ottawa, Canada
Subsidiary: B-C INTERNATIONAL, LTD., Greener House, 66/68 Haymarket, London, S. W. 1, England

American Cyanamid Co. has leased a 60,000-sq. ft. building at 1055 Commonwealth Avenue, Boston, Mass., to house its operations. The new facilities replace four separate offices and four warehouses. The units that will use the facilities are Calco Chemical Division, Dyestuffs Department and Pigment Department, the Industrial Chemicals Division, the Coating Resin Department of the Plastics and Resins Division, and the Lederle Laboratories Division. American Cyanamid Co. is the fourth largest chemical manufacturing concern in America.

The Company has announced also that construction will be started on a 64,000-sq. ft. building in Los Angeles, Calif.

* * *

Paul M. Bigley, Assistant General Sales Manager, Michigan Alkali Division, Wyandotte Chemicals Corp., has been appointed to serve with the Economic Stabilization Agency. Thomas R. Boyle will assume all duties handled in the past by Mr. Bigley.

* * *

The Polychemicals Department Laboratory of du Pont was dedicated on May 10. The work of this laboratory will be devoted to high polymers.

* * *

The Babcock & Wilcox Co., Madison Avenue, New York 10, N. Y., has issued a 104-page handbook on the properties and methods of working seamless and welded tubes and pipe of the B & W stainless Croloys. This book is intended for engineers, designers, and fabricators as a guide in choosing the proper material and as a help in planning the conversion of stainless steel tubing into finished products for industry. Copies of the book Technical Bulletin 1 B are available on request to the Babcock & Wilcox Tube Co., Beaver Falls, Pa.

* * *

The Advertisers Paper Co., 36 West 20th Street, New York 11, N. Y., has issued its Advertisers Handbook, designed to help the production man and paper buyer to understand the reproduction processes of the Graphic Arts. It covers selection of ink, paper, electrotypes, engravings and suggests best printing process suited for the job. Although this book is principally a price list, the other information given is of considerable interest.

* * *

Donald E. Springer has been appointed Assistant Chief Engineer of Hooker Electrochemical Co., Niagara Falls, N. Y. Mr. Springer has been chemical engineer for the Company since 1941.

* * *

The Dorr Co., Barry Place, Stamford, Conn., has issued Bulletin No. 7500 "FluoSolids Roasting of Sulphides." This equipment is used to make sulphur dioxide from pyrites or pyrrhotite to supplement presently short supplies of chemical sulphur. Exceptionally high-strength gas is obtained with simple operation.

* * *

Lawrence K. Cecil has been elected Vice-President of Infilco Inc., Tucson, Ariz. Mr. Cecil has been general sales manager since 1950 following 25 years experience as sales engineer for the Company. Infilco, Inc., recently moved its headquarters to Tucson after being located for 50 years in Chicago. The Company is a leading manufacturer of water conditioning and sewage treatment equipment.

* * *

Minneapolis-Honeywell Regulator Co., Philadelphia 14, Pa., has issued two interesting bulletins. Catalog 15-15 on "Electronite Potentiometers" and "Fundamentals of Industrial Electro-Chemical Measurement and Automatic Control."

* * *

Eriez Manufacturing Co., Erie 6, Pa., has issued a 16-page catalog (No. 15) on "Permanent Magnetic Separators."

* * *

Westinghouse Electric Co., Box 2099, Pittsburgh 30, Pa., has issued a booklet (DB-4073) on Coordinated Protection of Motors. Booklet (B-4739) describes large induction motors. Booklet (B-4761) describes the sound films available to organized groups. A full-line catalog (SA-6692) covering comparisons, heating coils, air-handling units, etc., may be obtained from Westinghouse Electric Corp., Sturtevant Division, 200 Readville Street, Boston, 36, Mass.

* * *

The following are data on the new Fourdrinier paper machine that recently went into operation at the Finch, Pruyn and Co. in Glens Falls, N. Y.

On order since March, 1950, the new machine was under construction between 8 and 9 months at the Pusey & Jones Corp. of Wilmington, Del.

According to R. I. Wynne-Roberts chief engineer of Finch, Pruyn and Co., 6 weeks were required to accomplish the monumental task of dismantling the old paper machine, built and installed in 1905, and installing the new machine. This work was done by Finch, Pruyn employees in collaboration with the construction firm of Waggaman and Collyer of Glens Falls.

Two hundred and fifty feet in length, with a 122-inch wide wire cloth, the new Fourdrinier machine features all of the most modern innovations.

To give an idea, in nontechnical terms easily understood by laymen, of the comparison between the new machine's capabilities and those of the one it replaces, a few figures are cited. The new machine is designed to produce 75 tons of paper per day as compared to an average of about 50 tons daily by the old. It is designed to operate at a maximum speed of 1000 feet per minute, as against 750 feet, and has a potential speed of 1200 feet a minute. It produces paper of the highest grade, being equipped with a sizing and coating press expressly for this purpose. The machine is equipped with 49 driers—thirty-nine 4-foot driers and ten 4-foot felt driers.

Another modern feature of the new machine which, according to Mr. Wynne-Roberts, proves for greater flexibility of operation, is a steam turbine, a compact and highly efficient piece of equipment that replaces a Corliss steam engine which drove the old machine.

Although the Finch, Pruyn and Co., Inc., mill was built in 1904, constant replacement of obsolete and worn equipment has kept it one of the most modern mills in the country.

Improved type Finch, Pruyn headbox arranged for attachment direct to screens and combined with 60-inch high fully adjustable slice; all stainless steel construction.

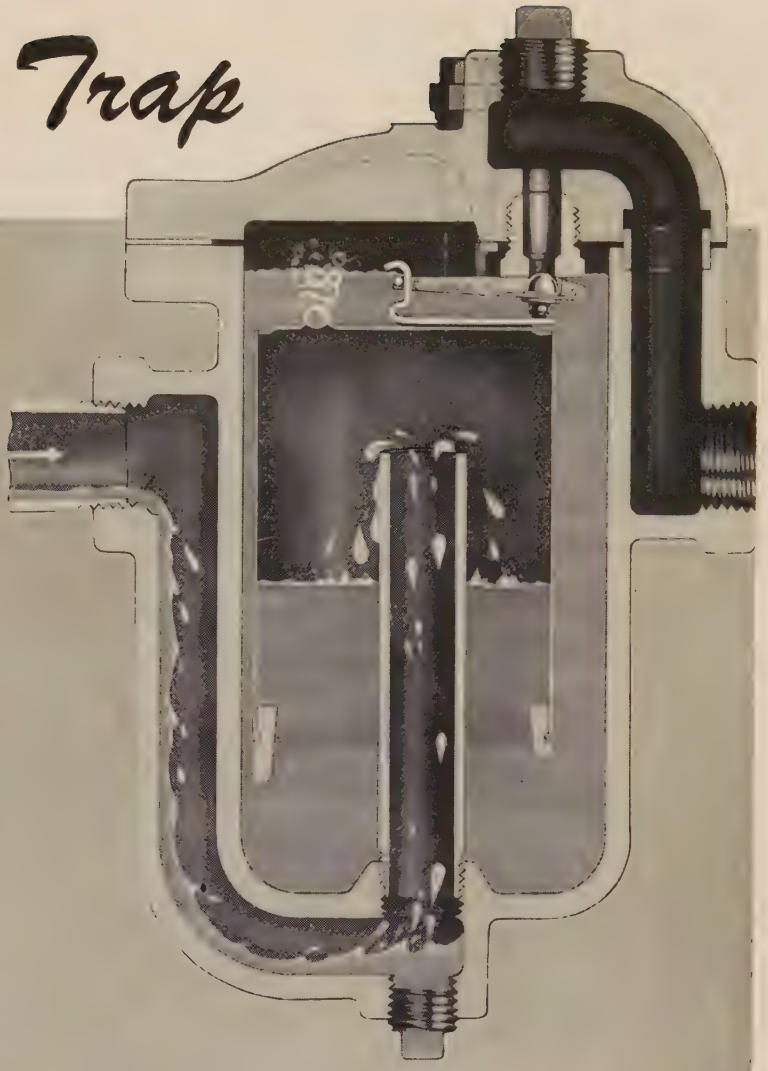
Fourdrinier part suitable for a wire 75 feet long, 122 inches wide, equipped with 30-inch diameter Downingtown suction couch, 6–7-inch wide stainless steel suction boxes, 18-inch diameter Sinclair dandy roll, 5-inch diameter rubber-covered table rolls, 10-inch diameter brass jacketed wire rolls, high-speed duplex shake, 3-inch permanent-pitch wire table, special air-operated handling device for breast roll, copper and brass water piping and showers.

Press Part of improved, close-spaced design with 2–24-inch diameter rubber-covered Downingtown suction presses and 24-inch diameter granite upper rolls. Pneumatic-controlled pressure loading with both presses of straight-through arrangement and felts equipped with Scofield felt conditioners. Wet and smoothing press with 24-inch diameter bronze cased lower and 24-inch diameter rubber-covered upper rolls.

Dry Part in three main sections having one upper and one

This Steam Trap

MEETS THE REQUIREMENTS of Paper Machine Drainage



1. FAST VENTING OF AIR

2. LOW MAINTENANCE

STEAM traps haven't always worked so well for draining paper machines. First, they wouldn't vent air fast enough, so that heat-up was slow after the machine had been down. Second, they didn't wear too well.

The Armstrong No. 813D steam trap was designed to answer these objections. That it does has been proved by many mills with individual 813D traps on each dryer.

Large air venting capacity is secured with oversize bucket vents.

Long life with infrequent maintenance has been secured by:

1. An extended inlet tube which admits condensate, steam and air into the trap above the water level in the bucket. This eliminates excessive wear-producing agitation of the mechanism.

2. Chrome steel valve and seat — hardened, ground and lapped — same as used in traps for 900°F., 950 psig. All other working parts 18-8 stainless steel, heavily reinforced for wear.

With this trap you get all the advantages of simplicity, economy, dependability and fast drainage with none of the previous disadvantages. SEND FOR BULLETIN No. 205.

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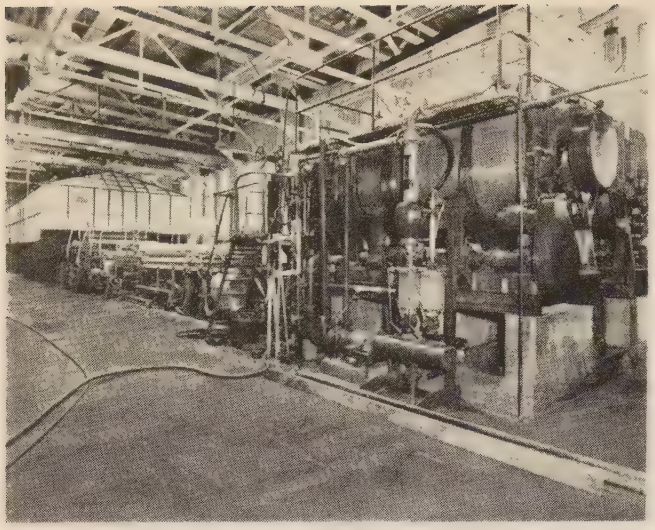
905 Hoffman Street, Three Rivers, Michigan

ARMSTRONG

Moisture Control Systems
Individual Dryer Temperature Controls
Paper Machine Drainage Traps
Inverted Bucket Steam Traps
Steam Humidifiers



New fourdrinier at Finch, Pruyn & Co., Inc.

lower felt on each section; first and second sections each comprising 14 paper and 4 felt driers; third section, 11 paper and 2 felt driers; all driers 48-inch diameter, designed and constructed for 50 pounds working steam pressure. Bowser lubricating system for main drier and drive shaft bearings. Rope carrier device for threading the sheet through the drier sections. Latest type steam joints with dual revolving siphons. All supporting framework of streamlined box pattern. Hi-tensil alloy gearing with welded steel protective guards.

Size Press comprising 24-inch diameter chromium-plated lower roll and 24-inch diameter rubber-covered upper roll with stainless steel size pan, brass showers, and special Mount Hope type adjustable spread roll.

Calender Stack comprising 10 rolls of 24-inch diameter bottom, 16-inch diameter next bottom, and 12-inch diameter upper, with Bowser oiling system for all roll bearings, pneumatic nip loading system, and Lodding doctors.

Improved Type Pope Reel with pneumatic adjustable loading mechanism and adjustable spreader to handle rolls up to 48-inch diameter.

Unwinding Stands with adjustable bearing supports and electrical regenerative brake.

Pusey & Jones 2-drum winder of improved design, suitable for winding rolls up to 42-inch diameter, with special arrangement of score-cut slitters; variable speed direct-connected double motor drive.

Mechanical drive for each section with individual enclosed spiral bevel gearing, Airflex clutches, and motor-operated belt shifters. Basement line shaft driven from turbine.

All rolls throughout machine equipped with roller bearings and balanced suitable for maximum operating speed of 1000 feet per minute, except winder at 3800 feet per minute.

* * *

Major new installations will be placed in operation at the Covington plant of West Virginia Pulp and Paper Co. when another step designed to streamline two of the mill's principal operations unfolds here this week.

This is phase two of a four-stage project which ultimately will transform the mill's previously scattered pulpwood handling and chipping operations and its pulpmaking facilities, except bleaching, into two compact straight-line operations, balanced equally for pine and hardwood production. All these operations will be located on the east side of the Jackson River.

Plant officials expect this portion of its general modernization program to be completed in the spring of 1952.

"We expect these and other improvements already projected for the future to restore the Covington mill to the competitive position it once occupied in the industry and the profit position it once held among our own mills," said Crawley Williams, manager of the Covington plant. "All of these changes are directed toward increasing the efficiency of our operations and taking better advantage of the mixed wood supply available in this region. For the community and for the people who work in the mill they promise the long-term economic security that goes only with a sound, efficient and competitive operation."

The operating changes scheduled to take place call for quite a few personnel shifts. Temporary job assignments to form the work teams which will operate the new equipment for the time being have been worked out in detail in discussions between Company officials and representatives of Local 675 of the United Paper Workers of America, CIO, which represents employees of the Covington mill. The present changes will result in no reduction of the work force, it was explained.

Installations scheduled to start up between May 4 and 6 include a new hardwood yard, equipped to receive and handle by mechanical methods the great volume of hardwood sold to the mill by local farmers; a new consolidated chip house which replaces two such installations now operated, and two new units of the projected Consolidated Pulp Mill, which eventually will combine the output the No. 1 and No. 2 Pulp Mills presently operated.

The new woodyard will place the mill's capacity for handling hardwood on a par with its pine-handling facilities, which have been operating at the Dry Run Wood Yard since 1947. The new hardwood layout replaces a makeshift operation that had been set up temporarily until a new system could be worked out.

New facilities of the hardwood yard include a mile of new roadway, laid out in a double loop; a waterway about a quarter of a mile long, known as a flume, which will convey hardwood unloaded from trucks and storage piles to the barking drums; an additional barking drum; new facilities for log sorting, and a giant new conveyor of the latest type to carry pulpwood logs to the chippers.

Engineered to expedite the handling of large volumes of wood delivered by truck, since about 80% of the mill's hardwoods arrive in this manner, the new layout will provide every facility for fast entry, unloading, and departure. The Company has encouraged its wood producers to rig their trucks with the gear necessary for mechanical unloading by crane, a time-saving method developed by the Company which has been in operation here for almost a year.

The flume, built of steel plate and concrete, parallels the hardwood storage piles on the east side of the wood yard. Built at a slight pitch, the flume is fed by a pump capable of circulating about 14,000 gallons of water per minute. Water flows through the sluiceway, which is about 4 feet deep and 5 feet wide, at a speed of about 4 miles per hour. It is capable of conveying about 800 cords of wood to the barking drums in a 24-hour period. Bark and other foreign matter in the water is screened out ahead of the pump as the water is recirculated. Bark collected by the screens is processed and burned as fuel for power boilers.

The new hardwood yard, combined with the up-to-date pine yard with its giant wood bridge and sluice system, gives the Covington plant one of the most modern wood-handling systems of any paper mill in the country. All the equipment in both yards is operated electrically by master controls from a high tower which gives the operator a sweeping view of all operations. Plans have been laid for many progressive features, including the installation of banks of lights throughout the yard to facilitate night operations.

At the first stage of wood processing, the plant has added a fourth barking drum, which will be placed in operation this week to balance facilities for cleaning pine and hardwood. The new drum and one of the three presently operated will be devoted exclusively to hardwood production and the other

Mrs. Smith IS A CAUSTIC SODA CONSUMER

That's right. Multiplied by the millions, Mrs. Smith is a *big* consumer of household products that use huge quantities of caustic soda. Soaps, cleansers, rayons, cotton and linen goods, paper products — her annual appetite for these almost numberless commodities is enormous indeed.

Equally important too, are the industrial applications of caustic soda. Today caustic soda is required for hundreds of products and processes, and the needs are constantly increasing. Established users are expanding and new users are constantly entering the picture.

Mathieson is already expanding its production to meet this increased demand and welcomes inquiries from those who might need future assistance in solving a caustic soda supply problem. Mathieson Chemical Corporation, Mathieson Building, Baltimore 3, Maryland.

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Sulphuric Acid • Processed Sulphur • Soda Ash
Caustic Soda • *Bicarbonate of Soda • Ammonia*
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Chlorine Dioxide

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CHEMICALS

SERVING INDUSTRY, AGRICULTURE AND PUBLIC HEALTH

two will be on the pine wood line. All the drums are king-size equipment. The huge steel cylinders that tumble the logs are as large as three rooms in an average house. Each drum can peel and clean about 400 cords of wood per day. Another installation on the hardwood line at this point includes new sorting equipment where logs too large for the chippers can be removed and logs inperfectly peeled can be recycled to the barking drums.

The most revolutionary piece of new equipment installed at this stage is a new rubber belt conveyor, 825 feet long, which will move peeled hardwood logs from the barking drums to the chip house. A prime illustration of the speed of mechanical changes in modern industry, the new equipment is a distinct departure from the pine wood conveyor line, a conventional drag chain type, installed only a few years ago.

The new conveyor, which parallels the older pine conveyor, is a continuous belt of rubber, looped over a series of steel rollers and powered by a 40-horsepower motor. The belt is 1700 feet long, spliced in one place, 3 feet wide, about $^1/_2$ inch thick, and weighs about 5 tons. Lower maintenance costs plus more efficient operation are advantages which engineers hope to gain from this new type conveyor.

The new Consolidated Chip House will be set up, on the east side of the river, in the old No. 2 Chip House, which has been completely remodeled. The remodeled building will house two giant 10-knife chippers, each capable of chewing up about 30 cords of wood per hour. The pine wood chipper was installed in the chip house in Aug., 1950, replacing smaller chippers which had been processing pine wood. Hardwood will be chipped by a twin piece of equipment, presently located in No. 1 chip house, which will be moved from across the river commencing April 30. Engineers hope to dismantle, move, install and start up the second chipper during a 48-hour period, without interrupting pulp mill production.

When the new chip house begins operations, chips from all the mill's pulping facilities will be provided from this central point. Until the pulp mill consolidation is completed, both pine and hardwood chips will be trucked from this chip house, across the river to No. 1 Pulp Mill.

The hardwood unit, like the chipper it is being placed alongside, will be served by screens designed to remove under and oversize chips, and a new rechipper, which reduces oversize chips, rejected by the screens, to uniform pulping size. Undersize chips and sawdust which the screens sift out are burned with bark as power boiler fuel.

The Consolidated Chip House is equipped with two cylindrical steel bins built on the ground level, an innovation at Covington where such installations in the past have always been located in buildings above the digesters, which cook the chips into pulp. The new bins are equipped with intricate conveyor-belt and elevator systems which will deliver chips to the digesters and semichemical cookers. About 700 feet of conveyor belts and two elevators are included in the delivery system, which will be operated automatically from control panels in the pulp mill. The bins have sufficient capacity to give the mill a 15-hour supply of chips, which is about triple the storage space of the old system.

Eventually all the mill's chemical and semichemical pulping operations, with the exception of bleaching, will be centralized on the east side of the river, but the only new pulp mill installations scheduled to go into operation at this stage include a new semichemical pulping unit and a second line of new rotary vacuum washers. This equipment is located in a new steel-and-tile building, erected recently adjacent to No. 2 Pulp Mill. After the present No. 2 Pulp Mill has been completely remodeled and sufficient new equipment added, it, along with the new building, will be known as the Consolidated Pulp Mill.

The semichemical unit is a new type of continuous cooker which will make pulp from hardwood for nine-point corrugating board, used in the manufacture of shipping containers. The new unit eventually will be operated alongside two older semichemical units, now located in No. 1 Pulp Mill, which will be moved to the Consolidated Pulp Mill as the improvement program progresses.

The full capacity of the new semichemical cooker will be utilized to make pulp for nine-point corrugating board until the consolidation of these units is completed. Because of greater versatility provided by highly technical improvements incorporated in the new unit, it may be used at some future date to experiment with finer grades of semichemical pulp, plant officials said.

The new rotary vacuum washers going into operation at this time will serve the new semichemical layout. This is a two-stage unit, equipped with huge cylinders, measuring $11^1/_2$ feet in diameter and 16 feet in width, which carry the pulp through the process. To improve the quality of the pulp, the plant has introduced a "hot" refiner system in the new semichemical line, by which hot stock from the cooker passes from the crushers, which separate the fibers, to two Sutherland refiners of the type generally used to prepare finished stock for the paper machines. The refiners will process the pulp before it enters the washing system, assuring a cleaner and more efficient wash than is obtainable in the normal process.

The two-stage unit eventually will clean all the pulp produced by the three semichemical units, replacing a small single-stage washing unit now serving two semichemical cookers located in No. 1 Pulp Mill. The two washers for the semichemical pulp line have been installed alongside a large three-stage unit which has been washing pulp on the pine line since March 25. A third three-stage unit will be installed later for the hardwood line. The pine washers replace eight pan-type batch washers in No. 2 Pulp Mill and the third line will replace nine pan washers now located in No. 1 Pulp Mill.

Plant engineers expect the three lines of new washers to bring about improvement in the condition of the river since they will provide a closed system at this stage of the process, keeping out of the stream some of the weak wastes which have been discharged from the pulp mill in the past. Because the efficient new units require less water to wash the pulp clean, the rotary washers can remove waste liquor from the pulp at high concentration. All wash water too weak for processing in the recovery system is contained in the system and reused until its liquor strength builds up to a point where the recovery evaporators can handle it. Because of the great volume of water required to wash pulp by the old batch system, highly dilute waste water, known as weak washings, which could not be handled by the recovery units, had been discharged into the river.

The new washers are models of operating ease, with push-button controls for every phase of the operation. Large console instrument panels are located alongside each unit, allowing the operator to control the entire job with his finger-tips. All the operating and production data of the three units will be automatically recorded on a large control panel.

Built over each line of washers is a large hood which funnels steam and fumes into a ventilating system which discharges into the atmosphere. This system eliminates most of the heat and odors usually associated with the old batch operation, improving to a great degree the working conditions of the operators.

* * *

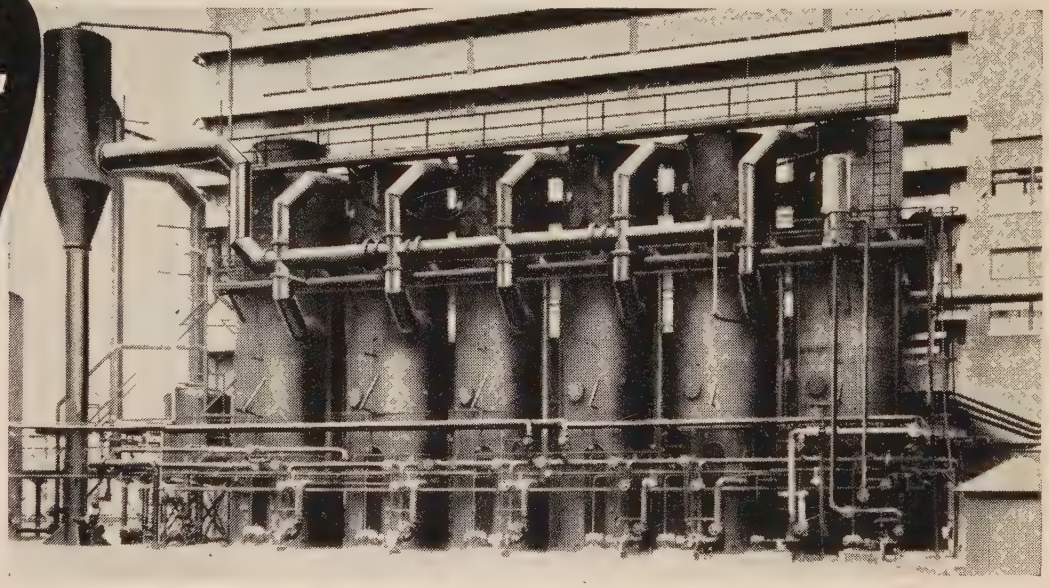
The *Industrial Bulletin* of Arthur D. Little, Inc., reports that Jute products remain one of the world's leading dollar-earning commodities, but current difficulties threaten their future. Dislocation of the jute industry upon the separation of India and Pakistan, exchange difficulties between Pakistan and India, and the tremendous growth of the multiwall paper bag industry have reduced production from a prewar average of 10 million bales, or four billion pounds, to 8.5 million bales in 1949. Price rises, however, have more than compensated for the loss in trade volume. In 1949, United States imports

See General American for

CREATIVE EVAPORATOR ENGINEERING

Installed outdoors or indoors . . . the new Conkey Integral Evaporator cuts overall evaporating costs

Designed to do your job best!



Conkey Integral Sextuple Effect Evaporator outdoor installation at southern pulp mill.

It's Self-Supporting—in more ways than one! Savings start the day the new Conkey Integral Evaporator comes into your plant. Unit is shipped fully assembled. A single up-ending operation sets it in place. As a result, you save on assembly, parts handling and erection costs. In addition, there are important savings in floor and building space—since no external centrifugal type separators, outside flash tanks and piping are needed. Where weather conditions permit, the entire unit may be installed outdoors—with no housing needed except for pumps and instruments.

Operating advantages of Conkey design are noteworthy. Because it reduces pressure drop losses between effects, it provides an increased working temperature drop across the heating element surface. This means a net positive gain in evaporation—extra evaporating capacity.

Long life—Integral construction eliminates many flanged joints, assuring both durability and tightness. For complete information that may be useful to your firm, write today.

Other General American Equipment:
Turbo-Mixers, Filters,
Thickeners, Dewaterers, Dryers,
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General Offices: 135 S. La Salle St., Chicago 90, Ill.

of burlap fabrics and bagging materials, the leading jute products, were valued at $103 million, compared with $41 million in 1937, although volume had dropped by a third to 447 million pounds. Jute is still the cheapest of the major fibers and ranks second in volume of production, with a tonnage a little less than half that of cotton.

Three quarters of the world's supply of jute is raised in Pakistan, with most of the burlap mills which supply the United States located in India. The Indian government has devalued its rupee by 30% and has placed a price ceiling on imported raw jute. Pakistan, which has not altered the par value of its rupee, has only recently reduced its price floor for raw jute to the level of India's price ceiling. Until a few weeks ago, there had been almost complete dislocation of jute trade between the two countries, relieved only by occasional trade agreements. To lessen dependence on an outside source, India has sought to increase its own jute plantings, although its food needs limit the acreage available for jute. Similarly, Pakistan, anxious to attain some industrial self-sufficiency, is starting to build weaving mills.

Burlap takes about 70% of total U. S. jute imports, with the remainder going into twine, webbing, and other products. Before the war, about a third of the bags used in this country were of burlap, but this year the proportion has dropped to about a fifth. Use of cotton bags has also dropped off rapidly since the war, but shipping sack paper has shown a steady increase, with about 60% of shipping bags now made of paper. Because conversion to use of multiwall paper sacks usually requires installation of special machinery, it is unlikely that burlap will ever regain its dominant position in this market.

Competition is not so keen in markets for other jute products, but alternative materials are gaining ground. About 120 million pounds of jute yarn are used annually by the carpet industry as a backing material. Paper twine, although weaker and stiffer than jute, is less expensive and currently accounts for about a quarter of carpet-backing material. Jute cloth as a backing for linoleum has almost disappeared, as manufacturers have found paper and felts satisfactory.

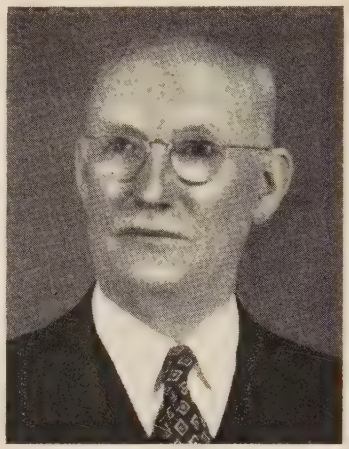
Besides yarn for carpet backing, the United States uses 40 million pounds of jute twine, with 15 million pounds of this going into electric rove, the fibrous packing material in electric wire and cable. This is meeting with increasing competition from paper and glass fibers, and combinations of the two. Before the war, a large quantity of jute twine was used for tying newspaper bundles by hand, but now most newspapers have shifted to steel wire which can be bound mechanically. As yet, a suitable jute tying machine has not been developed. Other miscellaneous uses of jute include webbing for upholstered furniture; scrim, a loosely woven fabric of fine yarn for reinforcing paper, and landing nets for the armed services. In all of these fields jute is meeting increased competition. Jute remains the only important material for the coarse, loosely woven, and inexpensive material used to cover bales of cotton. This market takes about 100 million pounds of jute annually. Another 20 million pounds is used in insulation and felting materials.

Jute's principal basis for wide usage is still its extremely low price, despite the postwar threefold increase. Although there has been a 40% rise in labor costs in India, up to 75% of the total cost of jute products is in the raw fiber. Primitive techniques of farming, processing, and transport contribute to this, as well as scattered small holdings. The industry, for the most part, has been reluctant to pursue development work on jute aimed at improving its physical properties and appearance, since further processing would exceed the cost of the raw material. Some experimental work has been done in combining jute with other inexpensive fibers, but to date this has not led to successful commercial development. Both the Indian Jute Mills Association Research Institute and the newly formed Jute Board of Pakistan, however, are placing increasing emphasis on research aimed at modernizing the industry.

OBITUARIES

Peter A. Paulson

Peter A. Paulson, consulting engineer for the sulphite pulp industry, died on May 10. He was born in Helsingborg, Sweden, on Sept. 29, 1879, and came to this country in his early twenties, determined to devote himself to pulp and paper engineering. After diversified activities with the West Virginia Pulp and Paper Co. in Covington, and the Brown Co. in Berlin, N. H., he joined the engineering firm of Barker's in Boston. The latter's system of preparing cooking acid for the sulphite pulping process represented a substantial improvement over those then in use. Among others, Paulson was sent to the Kimberly-Clark Corp., Neenah, Wis., to install the Barker acid-making system in their Kimberly mill. Evidently the new system was a success, for the Kimberly-Clark Corp. asked Paulson to install it also in their Niagara (Wis.) mill. This gave Paulson an opportunity to add further improvements to the new system. The excellent results obtained led to Paulson's engagement with the Kimberly-Clark Corp. in 1915.



Peter A. Paulson

He remained with this company until 1932. During these seventeen years and in his position as General Sulphite Superintendent, Paulson introduced a great many improvements and novelties in the field of sulphite pulping and of wood pulping in general, comprising wood handling, acid-making, and cooking, all of which resulted in greater economy, better yields, increased production, and improved pulp quality. A great deal of the improvements and novelties were first put to a successful test in the corporation's Kapuskasing mill, which Paulson built according to his plans before they were introduced in the other mills of the corporation.

After he left the Kimberly-Clark Corp. to become a consulting engineer, Paulson's reputation as an expert in the sulphite pulping field grew further, and his council was sought by many in this country and abroad.

Among the many problems which occupied his mind or in which he was active was the evaporation and burning of sulphite waste liquor, the principal ideas of which he had laid down in a patent which had been granted to him as early as 1921 and which is known as the Paulson process, comprising as it does a number of new features in its later version. When in recent years the pulp and paper industry, particularly in Wisconsin, paid renewed attention to a reduction of stream pollution, Paulson followed their studies, discussions, and large-scale experimental runs with great interest. Unfortunately, his failing health prevented him from taking a more active part in the new development, but he placed his process at the disposal of those concerned with the solution of the problem. Undoubtedly he would have derived much satisfaction from an eventual solution of this old problem, a solution to which he contributed so much and which today would seem to be almost within reach.

Paulson's reputation as a sulphite expert attracted many visitors from all over the globe. Many young men, students

kill these pests...

Typical slime-forming organisms

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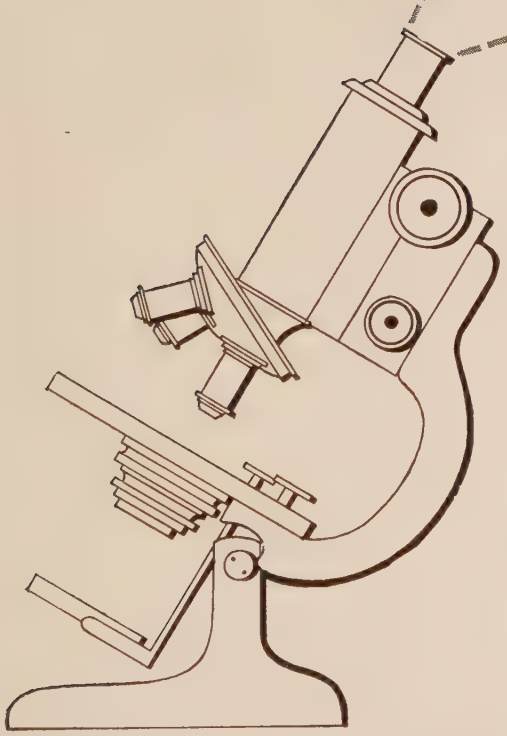

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Wallace & Tiernan Chlorinators are particularly effective in slime control work because they are especially designed from over 35 years' experience to give low cost, efficient performance.

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and engineers, sought and were gladly given his advice and were started on a career in this country and abroad.

The Paulson home, with gracious Mrs. Paulson in charge, excelled in a hospitality which will remain unforgotten by those who had the pleasure of enjoying it. There was indeed, great regret when they gave up their Appleton home in the summer of 1946 to live henceforth in California. Here, in Encinitas, in their new home "Casa de Hoy," located high on a cliff and overlooking the Ocean, Peter Paulson had hoped to spend his years in health and comfort, to enjoy the beautiful California scenery, some deep-sea fishing and other California diversions. Unfortunately these dreams did not come true. While he was confined most of the time to his home, he did much reading and took a new interest in Svedenborg, de Nouilly, and other philosophers and scientists as well as in foreign languages, of which he took up Spanish and a self-refresher course in French, displaying thus a remarkable energy. In fact, it seemed that he had rallied for making a new start. Then, unexpectedly, on the tenth of May, he closed his eyes forever.

Peter Paulson possessed a fine personality which commanded the respect and admiration of those who met him. His straightforwardness was refreshing and made one feel comfortable and secure. He was kind and generous to his fellow men.

Peter Paulson was a charter member of the Technical Association of the American Pulp and Paper Industry; a member of the American Society of Mechanical Engineers, a sustaining member of the Swedish-American Foundation, a member of the Swedish Club in Chicago, and a member of the Elks. He was a 32nd degree Mason and a member of the Wisconsin Consistory, Tripoli Shrine, El Hajj Jestors, and an honorary life member of the Masonic Order of Kapuskasing, Ontario, Canada.

The tribute which here is paid to Peter Paulson can only be limited since an appraisal of his contributions, concerning, as they do, the engineering aspect of pulp manufacture, must be left to those who are more qualified than the writer. There can, however, be no doubt that Peter Paulson's knowledge and experience as well as his conscientious and balanced council will be missed by many in his profession. For all those, who, as the writer were fortunate enough to be more close to him, a dear and faithful friend has passed away. He shall not be forgotten.

E. Heuser, *La Jolla, Calif.*

Charles W. Rivise

Charles W. Rivise, former Chairman of the TAPPI Patents Committee and an attorney-at-law specializing in patents, trade-marks, and copyrights, was killed while a passenger in an airliner with which a naval plane collided over Key West, Fla., on April 25, 1951, one year after the death of his wife, Hadassah G. Rivise.

Mr. Rivise was born in Zhitomir, Russia, on Sept. 9, 1899, and was brought to this country in his infancy by his parents. He attended the public schools of Philadelphia and graduated from the University of Pennsylvania as a chemical engineer in 1922, from George Washington University with a law degree in 1926, and from Washington College of Law with an M.S. degree, the same year.

He served as an examiner in the Patent Office in Washington, D. C., from 1923 to 1927, following which he joined the Philadelphia firm of Caesar & Rivise, with whom he remained associated until the date of his death.

Mr. Rivise was a recognized authority on patent law. He gave many lectures before professional societies and wrote many books and articles dealing with the subject. Many are being used as standard texts in law schools.

He served in World War I as an Army instructor in gas defense. In addition to being a member of the Technical Association of the Pulp and Paper Industry he was a member of a large number of technical and law societies and engaged in a number of philanthropic enterprises.

William M. Cary

William M. Cary died on April 14, 1951, at Jacksonville, Fla., following several months' illness. The Judge as he was well known was Production Manager of Kraft Pulp and Board Division, National Container Corp., Jacksonville, Fla.

Judge Cary was born in Sauk County, Wis., on July 11, 1882. He started in the paper industry in 1917 at the Gulf States Paper Co., Braithwaite, La., and Tuscaloosa, Ala., as a superintendent. He held this position successively for the Mobile Paper Mills Inc., North Carolina Pulp Co., and the National Container Corp. For a short period he was a consultant for the Combustion Engineering Co. in connection with the spray-type black-liquor recovery furnace.

He was a member of the Technical Association of the Pulp and Paper Industry.

Jalmar E. Heiskanen

Jalmar E. Heiskanen, Consulting Mechanical Engineer, Rauma, Finland, died on April 9, 1951, at Rauma.

Mr. Heiskanen was born in Savonlinna, Finland, on Sept. 18, 1887, and graduated as a mechanical engineer from the Technical University of Helsingfors in 1908.

His career as an engineer included employment by Karbula O/Y, Moore & White Co., Great Northern Paper Co., Moulton Engineering Corp., Champion Fibre Co., Enso Gutzeit O/Y, Haarto O/Y. From 1930 to 1949 he was a consulting engineer. In 1949 he joined Rache O/Y, Kangasniemi, Finland. He was a member of TAPPI since 1931.

Eugene N. Bechard

Eugene N. Bechard died suddenly on Tuesday, May 15, 1951, in Atlanta, Ga. Funeral services were held in Philadelphia, Pa., on May 21.

Gene was born in Ottawa, Ont., on June 1, 1886, and was employed as a salesman by the Eastwood-Nealley Corp. of Belleville, N. J., for 16 years, following which he represented this company and others as a manufacturer's agent in Atlanta, Ga. Mr. Bechard was a member of TAPPI and was prominent at meetings of the American Pulp and Paper Mill Superintendent's Association.

Leon S. Dixon

Leon S. Dixon, Consulting Engineer, died suddenly in New York City on Dec. 12, 1950. He was born at Medford Center, Me., on June 13, 1886, and graduated as a mechanical engineer from the University of Maine in 1908.

Mr. Dixon entered the pulp and paper industry in 1912 as a transitman for the Great Northern Paper Co. From then on he changed his company connection frequently and worked for the General Electric Co., Eastern Manufacturing Co., U. S. Quartermaster Corp., Riordon Co., Eddy Paper Co., Bogalusa Paper Co., Canadian International Paper Co., E. B. Eddy Co. In 1931 he became established as a consulting engineer in Bangor, Me. During the past few years he was consultant for Stone & Webster Engineering Co. and the Newport News Shipbuilding and Drydock Co. in its work dealing with the pulp and paper and other industries. He was a registered engineer in several states and in Canada.

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ASSOCIATION NEWS AND EVENTS

Research Appropriations Committee

The following members of the Technical Association have been appointed by the Executive Committee to serve until February, 1952, as members of the reorganized Research Appropriations Committee:

John L. Parsons, *Chairman*, Hollingsworth & Whitney Co., Waterville, Me.
Allen Abrams, Marathon Corp., Rothschild, Wis.
A. E. Bachmann, Missisquoi Corp., Sheldin Springs, Vt.
H. W. Bialkowsky, Pulp Div., Weyerhaeuser Timber Co., Longview, Wash.
W. F. Gillespie, Gaylord Container Corp., Bogalusa, La.
J. W. Hemphill, Johns-Manville Corp., New York, N. Y.
J. D. Malcolmson, Robert Gair Co., New York, N. Y.
A. L. Sherwood, Sutherland Paper Co., Kalamazoo, Mich.
K. P. Geohegan, Ex-Officio, Howard Paper Mills, Dayton, Ohio.
G. H. Pringle, Ex-Officio, Mead Corp., Chillicothe, Ohio.

The above organization represents a departure from previous practice wherein the Committee was constituted of divisional chairmen. In the new arrangement no committee or divisional chairmen are represented officially.

The research projects financed by the Association are initiated by individual standing committees in the various divisions. When a project is approved by a committee it is passed along to the Division Chairman for further approval. He, in turn, submits the project to the Research Appropriations Committee for review and approval. Finally the project is submitted to the Executive Committee to pass on its financial support.

Maine-New Hampshire Summer Meeting

The Maine-New Hampshire Section will hold its semiannual meeting on June 22–23, 1951, at the Eastern Slope Inn, North Conway, N. H. The technical program will be devoted to a consideration of "Semichemical Pulping."

On Friday morning, June 22, there will be a visit to the plant of the Brown Co., Berlin, N. H.

In the afternoon the following papers will be presented:

"Effect of Certain Variables on Semi-Chemical Pulping on Pulp Quality," by J. N. McGovern, Forest Products Laboratory, Madison, Wis.
"Ammonia—Base in the Neutral Sulphite Semi-Chemical Pulping Process," by R. M. Jones and T. E. Detcher, Barrett Division, New York, N. Y.
"Semi-Chemical Pulp Production with Revolving Discs Mills," by C. K. Textor, Bauer Bros. Co., Springfield, Ohio.
"Development of a System for Neutral Sulphite Pulping," by T. Agronin, Shartle Bros. Machine Co., Middletown, Ohio.
"Semi-Chemical Pulping with Sprout-Waldron Single Rotary Disc Refiners," by T. W. Small, Sprout, Waldron Co., Muncy, Pa.

This will be followed by the election of officers.

On Saturday morning there will be a panel discussion on the Semichemical Process led by W. A. Kraski, Solvay Process Co., Syracuse, N. Y.

Joseph J. Thomas, S. D. Warren Co., Cumberland Mills, Me., is Chairman of the Program Committee and J. Fife Wright of the National Aniline Division is Chairman of the Local Arrangements Committee. George A. Day of the Brown Co. is Chairman of the Maine-New Hampshire Section.

Empire State Summer Meeting

The Empire State Section will hold its annual meeting at Whiteface Inn, Lake Placid, N. Y. on June 27–30, 1951.

The technical program for Thursday morning June 28 is as follows:

"Industry's Role as Related to New York State's Pulpwood Supply," by G. A. Pezez, Asst. Manager of Woodlands, International Paper Co., Glens Falls, N. Y.
"Public and Private Forestry Get Together," by J. Victor Skiff, Deputy Commissioner, State of New York Conservation Department, Albany, N. Y.
"Utilization of Hardwoods for Chemical Pulp," by F. W. O'Neill, State University of New York, College of Forestry, Syracuse, N. Y.

The Technical program for Friday morning, June 29, is as follows:

"Trends in the Paperboard Industry," by P. S. Bolton, Robert Gair Co., Uncasville, Conn.
"Burning of Sulphite Waste Liquor," by W. J. Darmstadt and F. H. Richter, Babcock & Wilcox Co., New York, N. Y.
"Impact of Defense Requirements on the Pulp and Paper Industry," by Clinton K. Royce, Head, Packaging Section, Office of Naval Material, Navy Department, Washington 25, D. C.

The program for Saturday morning, June 30 is as follows:

"A Few Thoughts on Stream Pollution," by H. A. Spencer, Knowlton Bros., Watertown, N. Y.
"Printing Ink and Equipment Developments and Their Effect on Paper Requirements," by Lou Engelhart, Interchemical Corp., Elizabeth, N. J.
"Reciprocal Paper-Plastics Developments," by E. C. Jahn, State University of New York, College of Forestry, Syracuse, N. Y.

Chester G. Landes, American Cyanamid Co., Stamford, Conn., is Chairman of the Technical Meetings. K. E. Youngchild, American Cyanamid Co., New York, N. Y., is Chairman of Social Events. W. R. Willets, Titanium Pigments Corp., New York, N. Y., is in charge of mill visits. Paul L. Haggerty, George La Monte & Sons, Nutley, N. J., is in charge of publicity. J. F. Butterworth, Socony-Vacuum Oil Co., is in charge of reservations and finance. Henry J. Perry, *Paper Trade Journal*, is Chairman of the Empire State Section. The Metropolitan District, Empire State Section is host to the annual meeting for 1951.

The afternoon programs will feature trapshooting, boat trip, golf, and trip to Whiteface Mountain and the North Pole. An extensive social program is being arranged.

Corrugated Combining Conference

The Corrugated Containers Committee and the Lake Erie Section jointly sponsored a conference on "Corrugated Combining" at the Statler Hotel, Cleveland, Ohio, on Friday, May 18, 1951. F. D. Long of the Container Corp. of America, Chicago, Ill., presided as General Chairman.

This meeting will be reported in greater detail in the July issue of *Tappi*.

The papers presented at the Conference, which was attended by about 240 representatives of the corrugated containers industry, were as follows:

• UNSETTLED BLEACH LIQUOR FLOW CHART shows how bleach liquor can be prepared for immediate use, without settling, with close process control and sizable economies in equipment, labor, materials and space. For details on this process, send today on your company letterhead for Hooker Bulletins 201 and 242.

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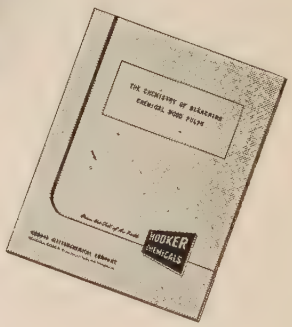
Send today, on your business letterhead, for helpful literature on pulp and paper bleaching.



SEND FOR THIS HELPFUL BLEACHING DATA

Bulletin No.	
201	Process and Equipment for Making Bleach Liquor for Use Without Settling
211	Chemistry of Bleaching Chemical Wood Pulps
214	What Do We Know About Bleaching?
236	Importance of pH and Catalysts in Bleaching Operations
242	Production and Use of Unsettled Bleach Liquor
243	Procedures and Brightness Grades in Bleaching Sulfate Pulps

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"Theoretical and Actual Strength Qualities of Corrugated Board," by R. C. McKee and C. Root, Institute of Paper Chemistry, Appleton, Wis.

"Present Operating Problems and Future Hopes of a Corrugated Superintendent," by R. T. Cassady, Vice-President, The Jackson Box Co., Cincinnati, Ohio.

"Past, Present, and Future Design of Corrugated Combiners," by Walter J. Goettsch, Vice-President, Samuel M. Langston Co., Camden, N. J.

"Theoretical Problems of Heating and Drying," by A. E. Montgomery, J. O. Ross Engineering Co., Chicago, Ill.

An unusually fine question-and-answer period followed the presentation of the papers presented. This discussion will be reported in a later issue of *Tappi*.

International Pulp and Paper Symposium

The following is a preliminary announcement of the International Pulp and Paper Symposium sponsored jointly by The Institute of Paper Chemistry, the Committee on the Chemistry of Plant Products of the National Research Council, the Wood Chemistry Subcommittee of the Food and Agriculture Organization of the United Nations, and the Fundamental Research Committee of TAPPI.

Monday, Sept. 17, 1951

Open meeting of the Wood Chemistry Subcommittee, FAO

Tropical Woods as a Source of Commercial Pulp

Reports by representatives of several countries on the progress being made in solving the economic and technical problems involved in tropical wood pulping.

Tuesday, Sept. 18, 1951

Open meeting of the Wood Chemistry Subcommittee, FAO

A.M. The Utilization of Agricultural Fibers as a Means of Supplying the Pulp Demands of Wood-Poor and Other Countries. It is hoped that reports will be presented on the preparation and properties of paper (and chemical) pulp from bamboo, straw, bagasse, esparto, etc.

P.M. FAO as an Agency for the Establishment of International Standards and Testing Methods in the Field of Wood and Wood Products

General discussions on other problems of international importance

Wednesday, Sept. 19, and Thursday, Sept. 20, 1951

Symposium on common technical problems of the pulp and paper industry under the sponsorship of The Institute of Paper Chemistry.

Friday, Sept. 21, 1951

Special informal round tables for the discussion of specialized topics—such as the current status of lignin chemistry (a continuation of the Lignin Round Tables hitherto sponsored jointly by The Institute of Paper Chemistry and the Committee on the Chemistry of Plant Products of the National Research Council), the significance of micro- and submicrostructure of pulp fibers, training for the pulp and paper industry, global raw material resources, pulp for chemical conversions, and/or others selected during the earlier sessions.

The third week in September, 1951, is particularly a happy time to hold an International Pulp and Paper Symposium following as it does the International Chemical Conclave being held in New York the first two weeks in September. The Conclave consists of the 75th Anniversary of the American Chemical Society which is being celebrated during the first week in September and the XIIth International Congress of Pure and Applied Chemistry which will be held the second week.

During the American Chemical Society meeting, of interest to chemists who are concerned with wood as a technical raw material will be three symposia held by the Division of Cellulose Chemistry titled (1) The Fine Structure of Cellulose, (2) The Nature of the Chemical Components of Wood, and (3) Problems in the Field of Textile Chemistry. Other symposia of interest include those prepared by the Division of High Polymer Chemistry.

Division 15 of the XIIth International Congress of Pure and Applied Chemistry is concerned with research reports dealing with the chemistry of cell-wall constituents. Programs have been arranged on the biosynthesis of cell-wall constituents, and on lignin, starch, the hemicelluloses, and cellulose.

The attendance of foreign chemists at the New York meeting will exceed seven hundred; this number will include some thirty to forty men from abroad who have contributed in an important way to the technology of the pulp and paper industry. The attendance of many of these men at the meetings in New York and Appleton has been made possible by the financial help made available by the pulp and paper industry in the countries of origin but especially by the industry in the United States and Canada and by The Institute of Paper Chemistry, the Technical Association of the Pulp and Paper Industry, and the Canadian Pulp and Paper Association.

The list of those from abroad planning to attend includes: O. Bryde, G. Centola, G. Champetier, S. Claesson, W. E. Cohen, G. F. Davidson, E. Hägglund, P. H. Hermans, J. K. N. Jones, A. Meller, B. Steenberg, W. G. Campbell, T. Enkvist, H. Erdtman, G. Aulin-Erdtman, P. W. Lange, E. Adler, H. Haas, Corte L. Rys, Leif Jörgensen, K. Freudenberg, M. Horio, Robert Peteri, A. Kratky, and W. Lautsch.

The registration fee for the meetings being held September 19, 20, and 21 for technical representatives from the pulp and paper and allied industries has been set at $35 per registrant. Registration forms will be sent upon request. For this purpose contact Harry F. Lewis, The Institute of Paper Chemistry, Appleton, Wis.

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But there's more to the story than that. To begin with, we make Purecal by *controlled precipitation* of calcium chloride and sodium carbonate. Temperature. pH, proportion of reactants, rate of addition and other variables are controlled automatically. So that the operator can produce any given particle size — even smaller than the finest ground limestone.

Which particle size? Well, here's how we arrived at Purecal M. We varied particle sizes over a wide range, checked them with an electron microscope. We compared each individual "size range"— one against the other — to find which produced the most opacity, brightness and hiding power. We found the size (.2 microns— same as titanium dioxide) that did that — and that size is Purecal M.

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TAPPI DIVISIONS AND COMMITTEES

Recent Reports of Activities

Engineering Division

Historical Background

The engineers in the pulp and paper industry were the largest individual group responsible for the organization of the Technical Association of the Pulp and Paper Industry in 1915. Through the following years, however, this interest gradually declined until in the 1940's the Engineering Division of TAPPI had reached an inactive status.

In February, 1946, G. W. E. Nicholson, Operating Vice-President of the Union Bag & Paper Corp., was elected to the presidency of TAPPI. The main objective of Mr. Nicholson's term as President was the reorganization of the TAPPI Engineering Division. This resulted in the organization of the first Engineering Conference which was held in Milwaukee in the fall of 1946. This Milwaukee Engineering Conference, which was set up on a national basis, resulted in an attendance of about 300 engineers of which a large percentage were mill representatives.

As a result of this reorganization of the Engineering Division, under Mr. Nicholson's direction, and the success of the Milwaukee Engineering Conference, it was decided to have a National Engineering Conference, sponsored by the Engineering Division of TAPPI, each autumn. This resulted in holding these conferences successively at Philadelphia, Buffalo, Boston, and Cincinnati. With each succeeding conference the interest and attendance have shown an increase and the percentage of mill engineers attending these conferences has shown a decided increase. At the 1950 Cincinnati Conference, the total registration was about 500 of which about 300 were pulp and paper mill engineers.

The first Chairman of this reorganized Engineering Division was the late E. F. Burns then Chief Engineer of the International Paper Co. Following the death of Mr. Burns, early in 1947, J. W. Hemphill of the Johns-Manville Sales Corp. assumed the General Chairmanship of this Engineering Division. Mr. Hemphill did an outstanding job by continuing the work started by Mr. Nicholson and Mr. Burns. Mr. Hemphill continued in this chairmanship until 1949 when, feeling that the Engineering Division should be headed up by a mill engineer, he gave up this chairmanship but was agreeable to remain as General Secretary, which position he still holds.

General Comments

Since the 1946 Milwaukee Engineering Conference, the Engineering Division has continued to grow until today it is one of the strongest and most active divisions in the Technical Association organization. This has resulted in a large number of engineers coming into TAPPI membership. The engineers that have been attending the fall engineering Conferences have come to the realization that there are very definite benefits to them by becoming members of TAPPI. On the other hand, TAPPI needs these engineers in its membership.

The Association magazine *Tappi*, which started publication in January, 1949, has also been a deciding factor in attracting these engineers to TAPPI membership. The engineers realize that this is the outstanding technical magazine published today and this has influenced them to take out membership. A large increase in the engineers joining TAPPI has also been a factor in the success of the magazine. The advertisers realize that the engineers, in most cases, recommend the type and make of equipment to be purchased for their operations and, such being the case, more and more companies are advertising in *Tappi* in order to reach these engineers in the industry.

1951 Engineering Conference

There has been a feeling for some time that one of these Engineering Conferences should be held in the South, particularly in view of the large expansion in the South during recent years and the advisability of having the engineers from other sections of this country and Canada, that attend these conferences, see some of these southern operations.

It is necessary to select the time and place of these Engineering Conferences at least a year ahead of time in order to secure adequate hotel accommodations. At the Annual TAPPI Meeting in February, 1950, the Union Bag and Paper Corp. extended an invitation to us to hold this 1951 meeting at Savannah. This appeared to us to be an excellent location as it was readily accessible, the hotel facilities were satisfactory, and it would give the engineers in attendance an opportunity to see the Union Bag & Paper Corp.'s operation in Savannah which is the largest totally integrated and most highly mechanized pulp and paper mill operation in the world. On the fourth day of this Engineering Conference we are to be the guests of the Union Bag & Paper Corp. In the morning we will visit their operations and, following a barbecue lunch on their own golf course grounds, more detailed plant visitations can be made in the afternoon for those interested. In addition, arrangements have been made for plant visitations to Southern Paper Board Corp., Herty Laboratory, Macon Kraft Co., Brunswick Pulp & Paper Co., and West Virginia Pulp & Paper Co.

This Sixth Engineering Conference is therefore scheduled to be held at the General Oglethorp Hotel in Savannah, Ga., on Oct. 15, 16, 17, and 18, 1951. As this is a resort hotel, we have made some other changes in our general program over that followed at the previous Engineering Conferences which should appeal to the engineers in attendance. On Tuesday evening, instead of having our sponsored cocktail party and dinner in the main hotel ballroom, at Savannah we will have a sponsored cocktail party, by the Allied Industries in the Savannah Area, which will be followed by a barbecue on the hotel grounds.

This Savannah Conference should be the outstanding one so far held. There certainly should be a large attendance from the engineers in the southern mills and the engineers from the other sections of the country certainly should attend in order to see these southern pulp and paper mill operations. The weather in Savannah, during the middle of October, should be ideal and, although we have always tried to eliminate as much social activity as possible from these Engineering Conferences, the General Oglethorp, being a resort hotel, should have some further appeal.

The local arrangements for this Savannah meeting are being handled by a committee in Savannah under the General Chairmanship of J. R. Lientz of the Union Bag & Paper Corp. Mr. Lientz is also Chairman of the Chemical Engineering Committee of the TAPPI Engineering Division.

Committee Organization

The practice of having a paper mill or consulting engineer as Committee Chairman and a manufacturers' representa-

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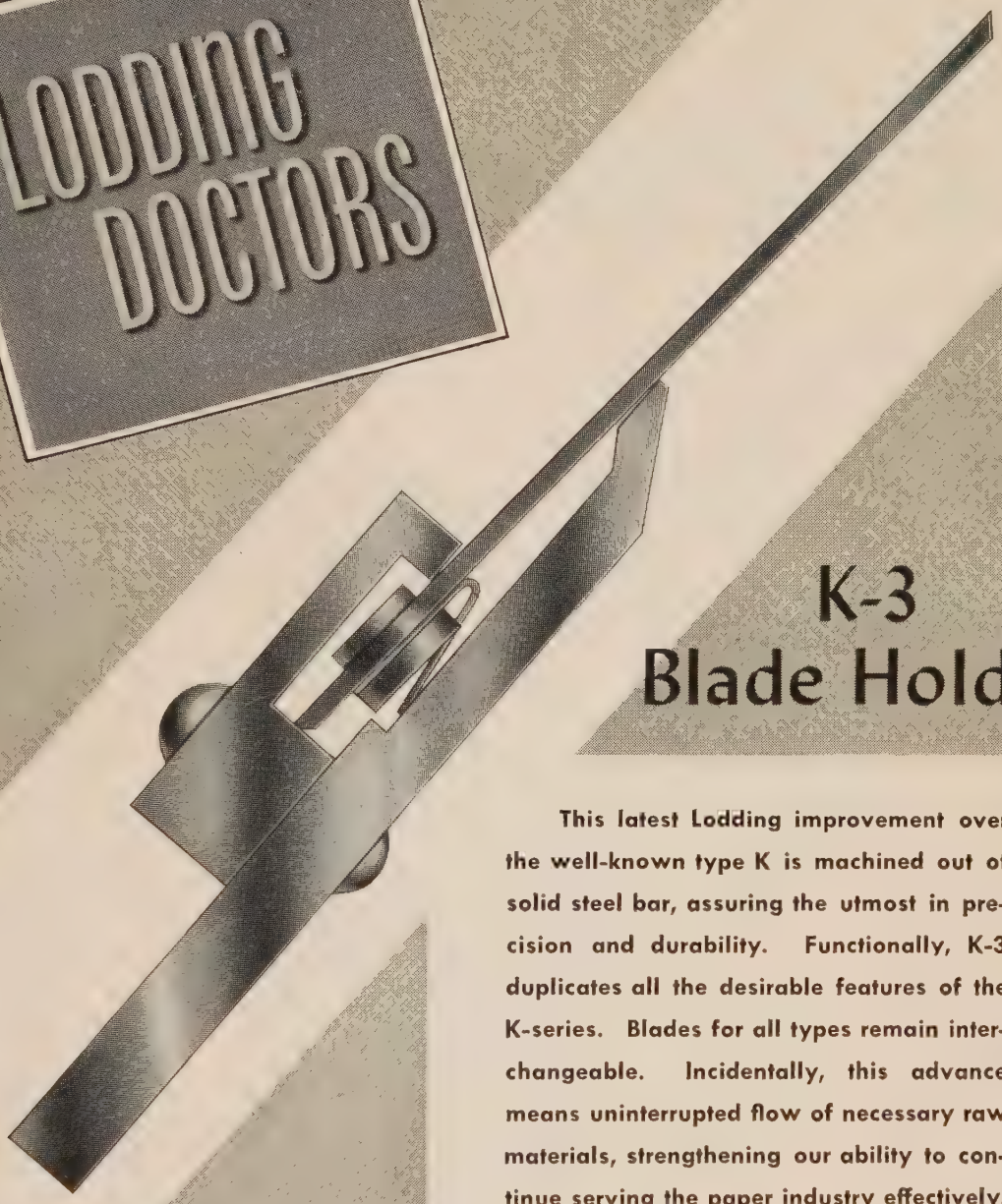

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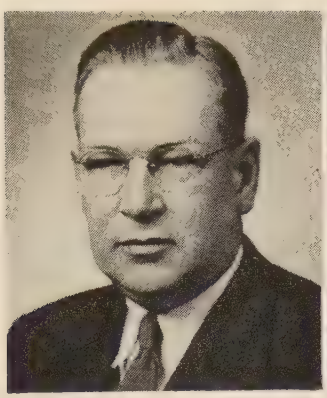

G. H. Pringle, General Chairman, Engineering Division

J. W. Hemphill, General Secretary, Engineering Division

tive as Secretary was started in the Engineering Division a number of years ago. This arrangement has been very satisfactory. The manufacturers supplying our industry have been very cooperative and have permitted their representatives to be very active on these committees, serving in the capacity of Secretaries. This has relieved the mill engineer from considerable detail work and has resulted in a much closer tie between the two groups.

At the present time we have ten committees in the Engineering Division and they are all very active on committee projects as well as arranging their program for the Savannah Engineering Conference.

At the Engineering Conference in Savannah, we have arranged to have technical papers presented in the mornings and early afternoons with open discussion periods in the late afternoons, on the first three days. These afternoon discussion periods have been very successful resulting in very complete participation by both mill men and manufacturers' representatives. At the 1950 Cincinnati Conference, the discussion sessions on "The Friction of Stock in Pipes" and "Digester Corrosion" were probably the most outstanding part of the entire program.

Chemical Engineering Committee

This committee, at its own request, became a part of the Engineering Division about two years ago. J. R. Lientz of Union Bag and Paper Corp. is Chairman and R. E. Bergstrom of Swenson Evaporator Co. is Secretary.

The Chemical Engineering Committee is the only one of the Engineering Division that has confined its main activity to the February Annual TAPPI Meeting. This was thought desirable due to the fact that the Engineering Divison should have some part in the program of this Annual Meeting and the group in attendance would be more interested in the chemical engineering phase than any other.

The main project of the Chemical Engineering Committee is its study of the very important problem of digester corrosion. It has a subcommittee studying this project of which Mr. Lientz is serving as Chairman and H. O. Teeple of the International Nickel Co. is Secretary. The Digester Corrosion Subcommittee is working very closely with a similar committee which has been organized by the Technical Section of the Canadian Pulp and Paper Association. This committee is doing outstanding work and will have a report on their progress to date at the Savannah engineering meeting. It will also devote its afternoon discussion period to this subject.

Data Sheets

This committee is under the chairmanship of Henry Perry, Editor of the *Paper Trade Journal*, and has representation on it from all of the other committees in the Engineering Division.

During the last year, this committee has processed about 25 data sheets. It has been rather difficult to obtain the material necessary in order for this committee to make a real showing.

At the February, 1951, meeting of the Executive Committee of TAPPI, funds were appropriated to assist this committee in obtaining material and we are requesting each local section of TAPPI to set up, on a relatively permanent basis, a Data Sheet Committee. Under these conditions, we expect to receive considerable data during this year which will be processed by the Data Sheet Committee and made available to the membership of TAPPI.

The long-term objective of this committee is to eventually edit and publish an engineering handbook on the pulp and paper industry.

Drying and Ventilating

This committee has Marshall L. Barker of the Beckett Paper Co. as Chairman and Robert M. Cook of Midwest-Fulton Machine Co. as Secretary.

The program for this committee at the Savannah Engineering Conference is not complete to date but it intends to have one paper on "Grinder Room Ventilation" and a possible paper on "Machine Room Supply and Exhaust Air Requirements."

A grant for funds was made to this committee to enable them to have translated an article which was published in a German journal entitled "Application of the Laws of Drying and Ventilating to Design and Operation of Pulp and Paper Drying Machines" by Karlschmidt. This translation is now being made at Madison and should be available for publication shortly. This translation may be used as part of this committee's program at Savannah as a third paper for their technical session.

Another project of this committee is the assembly in final form of the paper machine drying curves, the data for which were obtained some time ago by Mr. Sawyer who made a survey of a large number of paper mills. This work was done under the chairmanship of A. E. Montgomery of the J. O. Ross Engineering Corp. The plotting of these data in the form of curves, together with a descriptive write up, will be completed within the next few weeks and will probably be used by this committee for their discussion period at the Savannah meeting.

Electrical Engineering

This committee has Ray Foster of Champion Paper & Fibre Co. as Chairman and Geo. W. Knapp of the General Electric Co. as Secretary. This is one of the newer committees in the Engineering Division and has been doing some outstanding work.

At the Savannah Engineering Conference, this committee will present two papers, one entitled "The Power Requirements of Fourdrinier Sections" and the other "The Application of Cables in Pulp and Paper Mills." They will devote their round-table discussion session to the "Power Requirements for Press Sections of Paper Machines."

The main project on which this committee is now working covers the power requirements for all types of machinery in pulp and paper mills. This covers a very large field and this committee will have to continue working on this project for some time before a complete coverage can be published. It plans, however, to issue data sheets from time to time as soon as each phase of this project is ready for publication.

It is working also on a two-year project covering motor applications for the pulp and paper industry. This work is pretty well along and will be ready for publication and issuance in data sheet form in the very near future.

Engineering Research & Machine Design

This committee has as its Chairman John D. Lyall of the

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The *Slush-Maker* completely defibers high wet strength papers, even in cold water, without damaging the fiber.

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J. D. Lyall, Chairman, Engineering Research and Machine Design Committee

K. J. Mackenzie, Chairman, Hydraulics Committee

Armstrong Cork Co. and as Secretary Raymond T. DePan of Downingtown Manufacturing Co. This is the only committee of the Engineering Division that had sufficient members in attendance in New York to have a luncheon as part of the Annual Meeting this year.

At the Savannah Engineering Conference, this committee will present two papers, entitled "A Study of the Calender" and "Capacity of Thickeners."

This committee has four subcommittees working on the following projects:

Centralized Control of Stock Systems.
A Study of Hardness for Rubber Covered Rolls and the Effect on Water Removal.
Machine Design Data.
Methods for Quickly Estimating Costs of Engineering Projects.

In the discussion period assigned to this committee at Savannah, reports will be received from these four subcommittees and discussion will center around these reports.

Hydraulics

This committee has as Chairman K. J. Mackenzie of Eastman Kodak Co. This committee has not to date completed its program for the Savannah Engineering Conference. It will no doubt cover either in its technical session or round-table discussion period their work to date on the project "The Friction of Stock in Pipes."

This committee received from the Executive Committee last February an appropriation of funds to carry on the work started on the friction of stock in pipes.

This is one of the most important projects now being handled by the TAPPI Engineering Division as it will mean much to both engineers and management to have something definite on this subject when calculating pumps and motors required to drive them. At the Cincinnati Engineering Conference, this committee presented some very interesting data on this subject which resulted in a very enthusiastic discussion period.

Maintenance and Materials

This committee has as its Chairman H. F. Parker of New York and Pennsylvania Co. and Chas. J. Brown of International Nickel Co. as Secretary. This committee will present at the Savannah Meeting two papers entitled "Use and Maintenance of Steel Sash in Pulp and Paper Mills" and "Electrical Maintenance including Electronic Equipment." For their round-table discussion they have chosen "Maintenance of Insulation."

Division & Chapters

This committee has a number of projects on which it is now working but none of these have reached a point where a report can be made. One of the most important ones covers a study of the Lubrication Requirements of a Pulp and Paper Mill. Further details of the projects of this committee will be available at a later date.

Materials Handling

This committee has as its Chairman A. P. Schnyder of Ebasco Services, Inc., and as Secretary H. F. R. Weber of Link Belt Co.

The program of this committee for the Savannah Conference is not as yet complete but will cover several phases of materials handling, including log transfers in general and possibly the handling of pulpwood in flumes.

This committee has no active projects on which it is working at the present time.

Mill Design and Economic Aspects

This committee has as its Chairman Roland A. Packard of South Hadley Fall, Mass., and P. A. Forni of the Mead Corp. as Secretary.

This committee has three papers for presentation at the Savannah Engineering Conference; these are entitled "Pump Difficulties in Paper and Pulp Mills," "Investigation of the Vacuum Drop-Leg Problem," and "Mill Engineers' Selection of the Paper Machine Drive, Part II." This committee has as a continuing project the "Mill Engineers' Selection of the Paper Machine Drive" and is organizing a subcommittee to handle instrumentation control for pulp and paper mills.

Steam and Power

This committee has as its Chairman C. J. Sibler of West Virginia Pulp & Paper Co. and W. C. Bloomquist of General Electric Co. as Secretary.

This committee will have two papers for presentation at the Savannah meeting entitled "Materials and Design of Piping Systems for High-Pressure, High-Temperature Service" and "Gas Turbine Applications in the Paper Mills." They will devote their round-table discussion session to "Cinder Collection" and "Education of Power Plant Operators."

This committee has at the present time no active projects on which it is working but intends to have prior to the Savannah Conference.

Conclusion

This Engineering Division report cannot be complete without mentioning the fine work being done by our General Secretary, J. W. Hemphill, and the Chairmen and Secretaries of all ten committees of the Engineering Division, as well as the individual committee members.

These committees are responsible for arranging the programs of the Engineering Conferences and carrying through to successful conclusions all the various committee projects which they have undertaken.

With such a fine and enthusiastic committee organization which we have in the TAPPI Engineering Division, there is no question but that we will continue to prosper and be a real factor in the future technical growth of the Pulp and Paper Industry.

Engineering Division Organization

General Chairman: Geo. H. Pringle, Mead Corp., Chillicothe, Ohio
General Secretary: J. W. Hemphill, Johns-Manville Co., New York, N. Y.

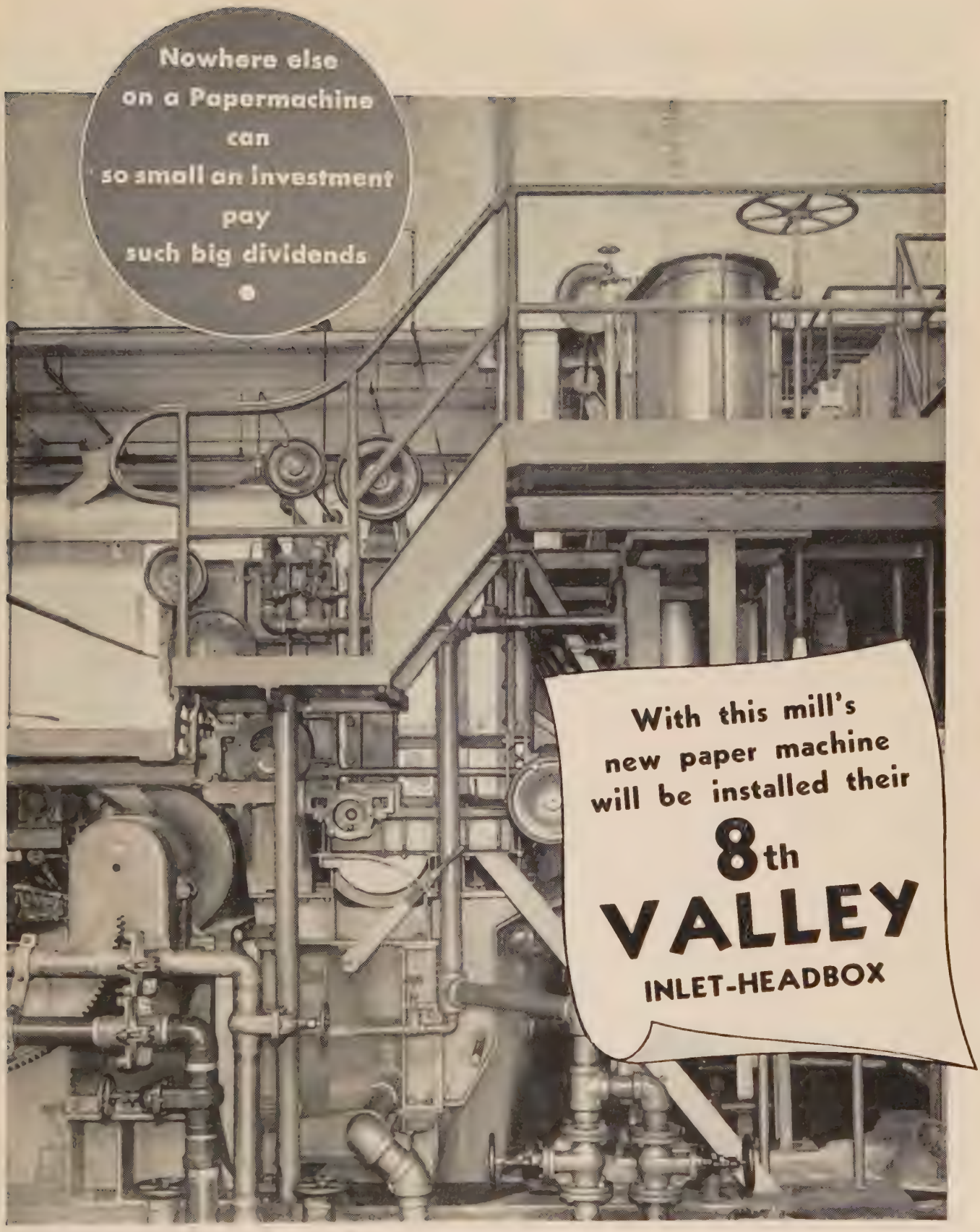
COMMITTEES

Chemical Engineering

J. R. Lientz, *Chairman*, Union Bag & Paper Corp., Savannah, Ga.
R. E. Bergstrom, *Secretary*, Swenson Evaporator Co., Harvey, Ill.

Electrical Engineering

Ray Foster, *Chairman*, Champion Paper & Fibre Co., Canton, N. C.



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A. P. Schnyder, Chairman, Materials Handling Committee

A. S. O'Brien, Chairman, Chemical Methods Committee

Geo. W. Knapp, *Secretary*, General Electric Co., Schenectady, N. Y.

Maintenance and Materials

H. F. Parker, *Chairman*, New York & Penn. Co., Inc., Lock Haven, Pa.
C. J. Brown, *Secretary*, International Nickel Co., New York, N. Y.

Data Sheets

Henry Perry, *Chairman*, *Paper Trade Journal*, New York, N. Y.

Engineering Research

John D. Lyall, *Chairman*, Armstrong Cork Co., Lancaster, Pa.
Raymond T. DePan, *Secretary*, Downingtown Mfg. Co., Downingtown, Pa.

Materials Handling

A. P. Schnyder, *Chairman*, Ebasco Services, Inc., New York, N. Y.
H. F. R. Weber, *Secretary*, Link Belt Co., Chicago, Ill.

Steam and Power

C. J. Sibler, *Chairman*, West Virginia Pulp & Paper Co., New York, N. Y.
W. C. Bloomquist, *Secretary*, General Electric Co., Schenectady, N. Y.

Drying and Ventilating

Marshall L. Barker, *Chairman*, Beckett Paper Co., Hamilton, Ohio
Robert M. Cook, *Secretary*, Midwest-Fulton Machine Co., Ohio

Hydraulics

K. J. Mackenzie, *Chairman*, Eastman Kodak Co., Rochester 1, N. Y.

Mill Design & Economic Aspects

Roland A. Packard, *Chairman*, South Hadley Falls, Mass.
Dr. P. A. Forni, *Secretary*, Mead Corp., Kingsport, Tenn.

GEORGE H. PRINGLE, *General Chairman*

Chemical Methods Committee

A. S. O'Brien succeeded Milton Fillius as Chairman of the Chemical Methods Committee. The impetus which Mr. Fillius has given to the committee work will be felt for a long time to come.

The discussions of the committee followed the agenda as prepared for the meeting. Specific comments were made on the topics which follow:

Those present at the meeting on Feb. 19 were:

A. S. O'Brien, *Chairman*, Eastman Kodak Co.
George Greminger, Dow Chemical Co.
Jack L. Harvey, National Bureau of Standards
C. P. Donofrio, New York State College of Forestry
J. C. Tongren, Hammermill Paper Co.
M. S. Kantrowitz, Government Printing Office
Peter VanWyck, Hercules Powder Co.
A. F. Martin, Hercules Powder Co.

The chairman presented a report of the Rochester Meeting of the Testing Division. (See the December, 1950, issue of *Tappi*, pp. 76A–80A.)

Moisture in Paper and Pulp

Geoffrey Broughton, Chairman of the TAPPI Subcommittee on Moisture, is cooperating with the ACS committee in the testing of the Karl Fischer method. Hercules Powder Co., Dow Chemical Co., and the National Bureau of Standards suggested that they could also cooperate in the testing of this procedure. In connection with oven drying, the representatives from the Hercules Powder Co. made three suggestions. (1) A good desiccant (for example indicating grade activated alumina) must be specified. (2) The pressure must be equalized inside the weighing bottle in order to avoid weighing errors. (3) Admitting a small constant amount of air into a vacuum oven will improve the drying by sweeping out moisture.

The Determination of Pentosans in Low-Level Pentosan Pulps

The interest shown at the Rochester Meeting in a method for the pentosan content of pulps containing approximately 0.5–1.5% pentosans was confirmed at the New York Meeting. There are several groups interested in accurate values for the pentosan when the level is less than 2%. Some preliminary work was reported by the Chairman summarizing work done at the Paper Service Division, Eastman Kodak Co., in which the sample size was increased to 10 grams and a modified distillation procedure employed. The colorimetric method for pentosans as reported by Browning [*Ind. Eng. Chem., Anal. Ed.*, 12, 499(1940)] was also suggested as a possible tool. The committee considered that a research project in this field might be advisable. The Chairman was asked to investigate this possibility.

The Bleach Requirements of Pulp

Since the discussion at Rochester, a report has been received by the TAPPI office from the Crown-Zellerbach Corp. summarizing work done there on modifications of T-214. Dr. Holzer, of our committee, has offered to follow this project and when the work has been completed, he will prepare specific changes for T-214. The methods T-202 and T-219 are not to be considered in the present revision.

The pH of Paper Extracts T-435

Mr. Kantrowitz reaffirmed the desire of his subcommittee to have the cold extraction eliminated from T-435. After considerable discussion, Mr. Kantrowitz agreed to have TAPPI methods for both the hot and cold extraction of paper provided these methods were given separate numbers. There was general agreement that the confusion between hot and cold extraction methods was unfortunate and should be avoided as far as possible in the future. The Chairman was requested to rewrite these methods and submit them under separate TAPPI numbers. The method for the hot extraction was to be identical with the ASTM hot extraction procedure. The cold extraction is to be assigned a new TAPPI number and submitted also to the committee for a vote.

Disperse Viscosity T-206 and T-230

Dr. Martin presented a résumé of the paper which was to be given two days later. A new viscometry technique was suggested in regards to the concentration at which viscosity measurements would be made. Adoption of this technique would focus attention on the solvent as the chief remaining point of discussion in various viscosity methods. Dr. O'Brien announced that the executive committee had made a grant for viscosity solvent work to be done at the Institute of Paper Chemistry. Dr. Martin was asked to submit written suggestions for a program of work to be carried on at the Institute. He was also asked to determine whether the project could be broken down into two parts, which could be worked on separately so that faster progress could be made.

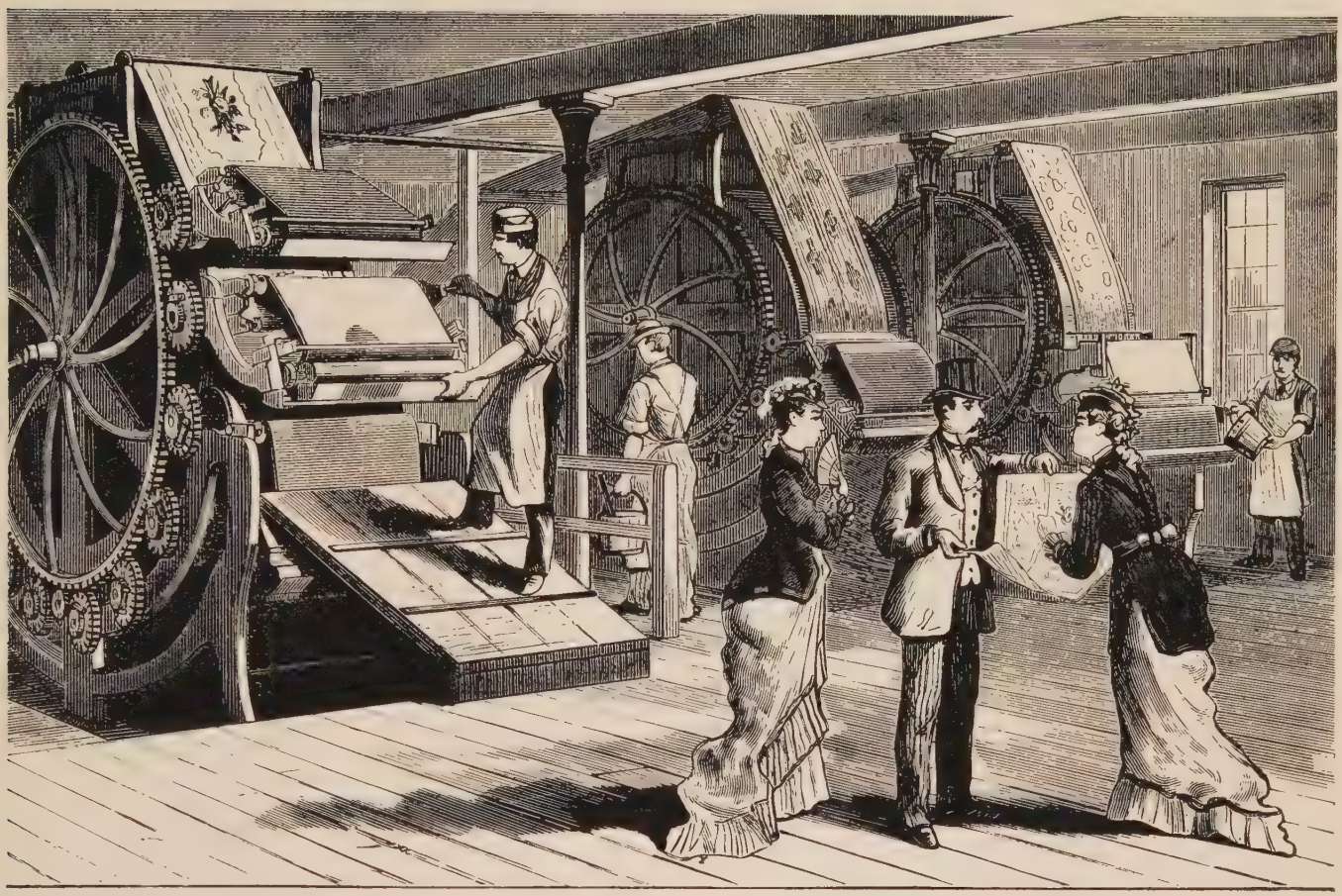

Illustration from the Bettmann Archive

Revolution in Wall Paper

First to make paper, the Chinese were also the first to make wall paper, hand painting small squares for decorating interiors. Dutch traders brought the idea to Europe, where designs were first applied by stencil. Late in the 17th Century Papillon in France introduced a process of printing paper squares and panels in elaborate design from engraved plates.

First made in the United States in 1750, wall paper continued to be produced in small sections by hand stencil and engraving. Then with the coming of volume paper production in the mid '60's the first machines were invented for printing wall paper in rolls.

Today modern high speed machines turn out millions of rolls of wall paper each year in infinite varieties of color and design. Through the enterprise of the pulp and paper industry and the resourcefulness of modern printing, the home decoration that was once the proud privilege of the rich has become available to every home in the land.

The dramatic story of paper is told in the sound-and-color film, "Paper — Pacemaker of Progress," and in a book under the same title. Both are presented by F. C. Huyck & Sons as a tribute to the Paper Industry. The book will be sent free upon request.

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It was also suggested that task groups should be organized to oversee the operation of these programs.

ASTM Committee Plans

The Chairman reported that a meeting had been held in Philadelphia on Nov. 29, 1950, at which time plans were discussed for the establishment of an ASTM Committee on Cellulose Derivatives. Both ACS and TAPPI were also represented. Dr. VanWyck reported on the importance of the new ASTM committee which would have the responsibility of collecting and publishing a complete list of test for cellulose and cellulose derivatives. In Dr. VanWyck's opinion, the activities of the American Chemical Society committees should be limited to the development of new tests, and to the fundamentals of cellulose chemistry. TAPPI should remain active in the development of all tests which are of interest to its members. ASTM would probably emphasize the product testing approach. A close cooperation is planned between all TAPPI chemical methods subcommittees and the ASTM committee.

The Interference in Paper Testing Caused by Wet-Strength Resins

Mr. Harvey of the National Bureau of Standards gave a brief résumé of the paper which he presented two days later on the analysis of paper containing melamine formaldehyde. He reported that the amount of interference appears to vary from one test method to another, upon the amount of the wet-strength agent added, and on the type of pulp to which it was added. It is difficult to predict the amount of interference. The tests investigated were T-408 Rosin in Paper and Paper Board, T-429 Alpha, Beta, and Gamma-Cellulose in Paper. T-430 Copper Number of Paper and Paper Board, T-435 Hydrogen Ion Concentration (pH) of Paper Extracts. Both Mr. Harvey and the other members of the committee discussed the magnitude of the whole problem involved when the total number of different resins is considered. It was generally agreed that no single reliable modification could be found to handle all wet strength agents, and that the activity of TAPPI along this line might have to be made specific for various wet strength resins. The interference in the alpha-cellulose procedure (the volumetric modification in T-429) proved to be less serious than was stated at the Rochester Meeting.

Alpha Cellulose in Pulp T-203

Dr. O'Brien reported the results of progress toward a revision of T-203, and recent progress in reaching a common method with ASC, and some of the compromises made. It was the consensus of the committee that the compromises in general weakened the procedure. Many seem insistent that at least a 2-gram sample be preserved in the official method. Also it was brought out that a group of cellulose companies had adopted the proposed TAPPI revision of about a year ago in which vacuum drying at 60° to obtain a dry sample was recommended over a separate determination of the moisture content. This tentative revision has been used by them for about a year with very encouraging results. Representatives of one of these industries strongly urged that TAPPI retain this feature in their original revision. The chairman was asked to draw up a revision based on discussions of the meeting making the method coincide with the ACS method wherever possible.

Fibrous Agricultural Residues Committee

The proceedings of the TAPPI meeting held in Peoria, Ill., on Nov. 13 and 14, 1950, were reviewed briefly by Dr. Aronovsky at the meeting of the Fibrous Agricultural Residues Committee held at the Commodore Hotel on Feb. 19 and 21, 1951. H. M. Blandin, chairman of the subcommittee on procurement, storage, and preservation, stated that relatively few straw ricks were treated with preservatives in 1950, since most of the mills expect that the straw stored in mill yards or on the farm will be used up before warm weather arrives in 1951. It was reported that some of the mills have gone after straw in Mississippi, Arkansas, Colorado, North Dakota, and even Canada to supplement the straw obtained from the 1950 crop in the Middle West. Many strawboard mills are now using soybean stalks as an extender for straw in their operations. It was also reported that sugarcane bagasse imported from Louisiana and even grasses and reeds from river bottoms are being used in the manufacture of strawboard for corrugating.

A lively discussion was held on the suitability of soybean stalks for corrugating paper. It was said the addition of 15% of cooked soybean stalks based on the total furnish would result in a paper with lower crush resistance. One man claimed, however, that he would just as soon have a furnish consisting of 100% pulped soybean stalks without any cereal grain straw pulp. All agreed, however, that soybean stalks require more chemical for pulping than is necessary for wheat straw and more power is required for hydrating and refining the soybean stalk pulp.

In connection with straw procurement, it was stated that there was no really reliable way of predicting the amount of straw available from year to year. While poor crop years present procurement problems, bumper crop years also create some problems. However, even in poor crop years sufficient straw supplies will be made available if the prices paid to the straw suppliers are right or reasonable. Everyone at this committee meeting agreed that the continuous educational program aimed at the farmers and other straw suppliers is necessary.

Dr. Aronovsky, reporting for the subcommittee on raw materials classification, indicated that the quality of the straw varied from year to year, depending on cultural conditions, weather, and also on the variety of the wheat. While the wheat straw variety may not have too much significance in processing for the production of corrugating or semipulp, it appears to have an important effect in pulping straw for fine and reading papers. As an example, wheat straw grown in Washington and Oregon consistently had a larger acetyl content than is found in midwestern straw. The western straw therefore requires larger amounts of alkali for pulping.

M. F. Knack, Chairman of the Subcommittee on Board and Paper Manufacture, will send out requests in the summer of 1951 to all of the operating strawboard mills to state problems dealing with their equipment and operations on which they would like to obtain help. Mr. Knack will then group the problems received and return them to the various mills in the form of a questionnaire, requesting them to describe the method which they are using or which they think might solve the problems, and return the questionnaire and the solution to him. The replies which he receives will serve as a basis for a round-table discussion at the fall meeting of this committee.

There were no reports from the Subcommittee on Testing due to the absence of the Chairman, N. F. Wilson.

It is expected, in accordance with the custom established by this committee, that the 1951 fall meeting will be held in a mill town. The date of the fall meeting and the location where it will be held will be announced later.

Dr. Werner Kaufmann, who heads the Industrial Division of TAPPI of which this committee is a part, sat in on the discussions during part of the meeting. After listening to some of the problems involved, Dr. Kaufmann suggested that it might be possible for this committee to obtain a research grant from TAPPI to aid in solving some of these problems. There was some discussion on this matter, and Dr. Aronovsky asked Mr. Burns and Mr. Krancher to contact the other strawboard mills to determine a suitable problem which can

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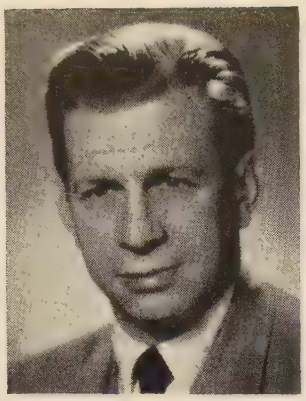

C. H. Krebs, Chairman, Container Testing Committee

C. S. Macnair, Secretary, Container Testing Committee

best be carried out in a research organization. They will also recommend an institution where this work under the TAPPI research grant can be carried out, and make an estimate of the amount of money necessary.

Those present at the committee meeting were: S. I. Aronovsky, R. H. Breyfogle, R. R. Burns, H. M. Blandin, L. E. Eberhardt, E. F. Carpenter, C. G. Krancher, J. R. Little, E. C. Lathrop, W. Kaufmann, and E. M. Pyatt.

Technical Session on Agricultural Residues, Feb. 21

Five papers were presented at this session:

1. "The Preservation of Baled Straw in Ricks," by C. W. White, Pacific Coast Borax Company, Cleveland, Ohio.
2. "Dissolving Pulp from Bamboo," by M. H. Joglekar, Timber Market, Bhusval, India, and C. P. Donofrio, New York State College of Forestry, Syracuse, N. Y.
3. "Mechano-Chemical Process—Rate of Delignification," by S. I. Aronovsky and G. H. Nelson, Northern Regional Research Laboratory, Peoria, Ill.
4. "Boxboard from Wheat Straw to Replace Wood Veneer in Wire-Bound Shipping Containers," by E. C. Lathrop, T. R. Naffziger, and Earl R. Stivers, Northern Regional Research Laboratory, Peoria, Ill.
5. "Agricultural Residue Pulps—Crotalaria Pulps," by A. J. Ernst, H. M. Sutcliffe, and S. I. Aronovsky, Northern Regional Research Laboratory, Peoria, Ill.

About 50 TAPPI members attended the session, including Pierre Delcroix, representative of the French Technical Association. There was some discussion after each of the papers. It was apparent from the questions asked that there is continued interest in the pulp and paper industry in straw and other residues as supplementary sources of raw materials for their products.

Container Testing Committee

The Advisory Committee of the Container Testing Committee met at the Hotel Claridge, Atlantic City, N. J., on April 17, 1951.

Those present were:

C. H. Krebs, *Chairman*, Atlas Boxmakers, Inc.
C. S. Macnair, *Secretary*, Acme Steel Co.
H. A. Bergstrom, Continental Can Co.
E. R. Stivers, Packaging Research Laboratory
Fred Atwood, W. C. Ritchie Co.
H. T. Scordas, Union Bag & Paper Co. (Alternate)
S. F. Thune, National Starch Products Co.
Albert V. Grundy, Quartermaster Food & Container Institute
Arnold Weeks, Bemis Bros. Bag Co. (Alternate)
Robert LeRoy, Bemis Bros. Bag Co.
F. A. Wilcox, Kraft Foods Inc. (Chicago Purchasing Agent's Assoc.)

The ASTM Committee D-10 Advisory Committee had agreed to the principle of coordination between the Committee D-10 and TAPPI's Container Testing Committee. ASTM had selected three men to represent Committee D-10 in all work of coordinating the committees of the two organizations. These three men were Harold Bergstrom, E. R. Stivers, and Albert V. Grundy.

To work in conjunction with this committee, TAPPI Container Testing Committee selected H. T. Scordas, F. D. Long, and C. S. Macnair.

All men selected are members of both committees and have been so recognized.

The Advisory Committee of the Container Testing Committee set out to blueprint the work that the committee will set out to do.

One of the first things decided upon was that the Coordinating Committee should screen all proposed standards before they are brought up to the tentative stage. It has been heretofore agreed by the ASTM Committee that this would be the function of the Coordinating Committee as far as ASTM was concerned.

All ASTM standards applicable to conversion to TAPPI will be converted as quickly as possible.

Suitable steps would be taken to request a research appropriation for the development of a movie; the first subject to be a drop test.

It was decided that whenever laboratory research is needed within the scope of the committee this work will be done by a commercial testing laboratory and an appropriation will be requested to cover the expense involved.

Excerpts from the Chairman's address to the Advisory Board are to become a part of this report as follows:

"This committee is going to be something different in many respects than any committee that has operated in the past.

"As we have told most of you individually at the time of the invitation to become an adviser, we intend to operate with an advisory group from which there will also be several subcommittees developed. In some cases members of the advisory group will be subcommittee chairmen, in other cases we will appoint other TAPPI members for chairmanships. The advisory group has been chosen with two aims in mind.

"1. That they are technically inclined in one or more phases of the container business, and they were chosen to represent a definite phase of the container business.

"2. That they are willing to devote a portion of their time to committee work for the good of the various industries.

"In the past, and according to the 1951 year book the scope of this committee is: 'the physical method of testing heavy container and container boards.' This differentiates the committee from the 'Containers Committee' which is in the Conversion and Consuming Division. The scope of the Container Committee is: 'The process of conversion to containers such as folding boxes, cartons, spiral containers, corrugated fiber boxes, etc.'

"For the purposes of coordination with Committee D-10 of ASTM it will be necessary for this committee to operate within the same scope as that in which they operate. It is as follows: '*Scope*—Nomenclature, definitions of terms, test methods, performance specifications, and study of the effect of various factors influencing strength and serviceability relating to packaging, including packages, shipping containers, and pallets.' It is our intent, and we have so informed Mr. Macdonald, Secretary of TAPPI, that the TAPPI Container Testing Committee shall have the same scope as ASTM Committee D-10.

"Temporarily our program lines up as follows with the first objects being:

1. Definition of terms applicable to containers in packaging.
2. A concept of packaging.
   (a) Why pack?
   (b) Why test?
   (c) What is rough handling and how can testing procedures be developed to produce and accelerate the effects of rough handling?
3. Classification of packages with subdivisions of make-up, material, size, density, fragility, and kind of internal support.

Turnabout,

*1741**

British soldier gets furlough to work in the Henchman Paper Mill.

**Being one of a series of the ingenuity of monographs demonstrating paper makers of yesteryear.*

WAR clouds hung heavy over Boston in 1741. The American phase of England's war with France was well advanced, as also was the demand for more and finer paper.

A few years previously Dan Henchman had been granted rights to build a paper mill on the Neponset River, a few miles from Boston. Not much paper was produced however, chiefly due to a shortage of qualified help . . . that is until 1741.

About then one of the mill owners had a good idea. He talked the local army authorities into granting furloughs to soldiers willing to work in the struggling Henchman mill...a unique idea, when judged by 1951 standards.

Since the earliest days, paper makers have encountered difficulties, but time after time they devised more efficient utilization of men, machinery and materials to meet the ever-increasing demand for more and still more paper.

Pennsalt research chemists always welcome the opportunity to help manufacturers boost production and lower costs. Specific inquiries are invited. *In the East:* Pennsylvania Salt Manufacturing Company, Philadelphia 7, Pa. *In the West:* Pennsylvania Salt Manufacturing Company of Washington, Tacoma, Washington.

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4. Measurements of containers with subdivisions for folding boxes, corrugated, solid fiber, bags, canisters, spiral containers, interior packaging, interior packing, case liners, and partitions.
5. Standards for sampling.
6. Standards for score line testing.
7. Methods for testing manufacturer's joints.
8. Methods for testing strapping and/or other reinforcing.

"When I review the above subjects I can see months and months of work ahead but each one of these is vitally important to the container business and first of all it is my own opinion that we should have agreement on terminology and methods of measurements."

F. A. Wilcox has been appointed to serve as Chairman of the Subcommittee on Definitions.

W. R. Tobin has been appointed as Chairman of the Committee on Methods of Measurement.

H. T. Scordas has been appointed Chairman of a Committee for Developing Test Methods for Manufacturers' Joints.

The following have been appointed to the board of advisers for the Container Testing Committee:

Fred Atwood, Adviser on Paper Tubes and Canisters, W. C. Ritchie & Co., 8801 S. Baltimore, Chicago, Ill.
H. A. Bergstrom, Adviser on Fibre Drums, Continental Can Co., P. O. Box 310, Van Wert, Ohio
Robert B. LeRoy, Adviser on Shipping Bags, Bemis Bros. Bag Co., East Pepperell, Mass.
Earl R. Stivers, General Counselor, Package Research Laboratory, Rockaway, N. J.
Malcolm L. Taylor, Adviser on Corrugated Shipping Containers, Union Bag & Paper Corp., Savannah, Ga.
Wendell R. Tobin, Adviser on Solid Fibre Shipping Containers, American Boxboard Co., Grand Rapids, Mich.
S. F. Thune, Adviser on Adhesives, National Adhesives Div., National Starch Co., 36th Pl. & Washtenaw Ave., Chicago, Ill.
Frank A. Wilcox, Representing the Chicago Purchasing Agent's Assoc., Adviser on Consumer Viewpoint, Kraft Foods Co., 500 Peshtigo Court, Chicago, Ill.
Charles Zusi, Adviser on Laboratory Technique, Container Laboratories, Inc., 112 W. Kinzie St., Chicago 10, Ill.

We believe that with this advisory board a strong committee has been formed. We plan to call our first meeting directly following the ASTM Committee D-10 Meetings in Atlantic City, April 17, at which time liaison between the two committees will be thoroughly discussed.

C. S. Macnair, *Secretary*

Paper Deinking Committee

The Paper Deinking Committee which has been dormant since Frederic C. Clark resigned as Chairman has been reactivated under the chairmanship of J. J. Forsythe of the International Paper Co., Niagara Falls, N. Y.

The membership of the committee consists of:

J. J. Forsythe, *Chairman*, International Paper Co., Niagara Falls, N. Y.
A. W. Infanger, *Secretary*, The Cowles Co., Cayuga, N. Y.
A. M. Altieri, Tileston & Hollingsworth Co., Boston, Mass.
M. D. Boggess, Beveridge Paper Co., Indianapolis, Ind.
P. S. Bolton, Robert Gair Co., Uncasville, Conn.
R. C. Bradbury, Mead Corp., Chillicothe, Ohio
J. L. Clouse, Oxford Miami Paper Co., W. Carrollton, Ohio
A. S. Erspamer, P. H. Glatfelter Co., Spring Grove, Pa.
F. L. Fennell, E. I. du Pont de Nemours & Co. Inc., Niagara Falls, N. Y.
F. C. Goodwill, St. Regis Paper Co., Kalamazoo, Mich.
J. H. Heuer, A. P. W. Products, Inc., Albany, N. Y.
W. E. Kirkpatrick, Allied Paper Mills, Kalamazoo, Mich.
R. W. Hynes, Newton Falls Paper Co., Newton Falls, N. Y.
M. H. Aber, Standard Paper Mfg. Co., Richmond, Va.

The Paper Deinking Committee is circulating a questionnaire among its members to establish a program which may lead to a much needed monograph on the subject of deinking as presently practiced.

Subcommittee on Alkaline Digester Corrosion

A preliminary meeting was arranged at the Roosevelt Hotel, New York, N. Y., Feb. 12 and 13, on rather short notice, hence, other members of the committee could not arrange for attendance. Those present were J. R. Lientz, *Chairman*, N. Shoumatoff, and H. O. Teeple. The purpose of this meeting was to assess some of the data derived from the returned digester questionnaires.

While neither time nor man power was available for a detailed analysis of the data, nevertheless some items of interest were extracted for use in the preparation of a Progress Report for submission to TAPPI, Wed. a.m., Feb. 21, during the Annual Meeting. The report presented at that time is to be considered a portion of these minutes.

Sunday Meeting, 2:00 p.m., Feb. 18, 1951, Hotel Commodore, New York, N. Y.

Members Present:

J. R. Lientz, *Chairman*
S. J. Baisch
F. W. Flynn
N. Shoumatoff
W. Smith
H. O. Teeple
R. P. Whitney

Others Present (PPRIC Steering Group):

L. R. Thiesmeyer
J. H. Ross
W. Boyd Campbell
J. Convey
W. F. Holzer
John Grieve
John Hart
W. W. Holland
Douglas Jones

This meeting was arranged for the purpose of permitting the Canadian Steering Group and the TAPPI subcommittee to meet and become acquainted. J. R. Lientz opened the meeting at 2:15 p.m. and continued by describing the progress to date of the TAPPI group. A brief résumé was given of the TAPPI Progress Report (presented at the Chemical Engineering Section meeting, Wed. a.m., Feb. 21). Specific mention was made of the fact that digester questionnaires were inadvertently sent to some Canadian mills. It was pointed out that such coverage was not the intention of the TAPPI committee, which preferred to work through already established liaison channels. It was further pointed out that the TAPPI committee planned to secure more complete coverage of the alkaline pulp mills in the United States.

Mr. Thiesmeyer, President of PPRIC, then gave a résumé of the progress to date of the Canadian group. He pointed out that the Canadian program has been financially underwritten by most of the Canadian sulphate mills for an initial 2-year period. The selection of personnel for a task force to accumulate data is now under consideration and probably will be completed by early Summer.

The meeting was thrown open following Mr. Thiesmeyer's remarks for general comments and suggestions as to further progress both groups might make.

The first item discussed was the coding of the information secured by both groups such that all information could be recorded by an IBM punched card system. Such a system could then be used for comparing pertinent accumulated data resulting from the activities of both the American and Canadian groups. It was pointed out that arrangements had been made for specific detailed discussion of the application of the IBM system during the TAPPI Digester Corrosion Committee luncheon meeting on Tues., Feb. 20.

It was suggested that small groups from both the TAPPI Committee and Canadian group be appointed to meet and work out the many details of the coding operation.

It was further suggested that a specialist in statistical analysis and operational research be hired to assist in the coding and interpretation of many of the intangible factors which would be uncovered during the course of the investigations.

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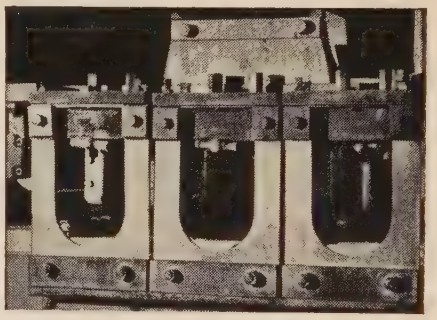
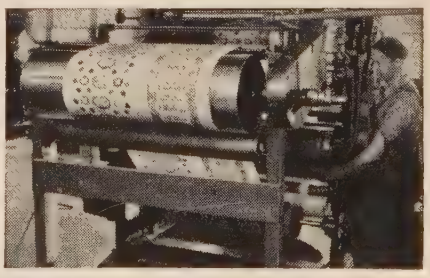
ABRASION and corrosion were minimized in this hydrapulper by using Lukens Nickel-Clad Steel. Machine is specially designed to replace less efficient, more bulky breaker beaters in paper and board mills. It combines the protection of nickel with the economy of steel. Fabricated for Dilts Machine Works Division of Black-Clawson Co., Fulton, N. Y.



FATIGUE from both vibration and corrosive action is a problem with suction box and shake springs. These were made from age-hardened Duranickel strip by Rice Barton Corp., Worcester, Mass. This new alloy has high mechanical properties and elasticity modulus, and ably withstands vibration and corrosion.



PITTING and rust blemishes were eliminated on this steel waxed-paper chilling roll by applying a 1/16th" Monel cover. Efficiency was stepped up so that machine speed could be increased by one-third. Photo courtesy of Minerva Wax Paper Co., Minerva, Ohio.

It seemed to be the consensus that the probable solution to the digester corrosion problem lay in future work and not so much in the information uncovered during the necessary study of past performance. It was felt trends would be discernible by a careful study of the accumulated data and certain directions would be indicated for future investigation.

Among the other items discussed was the possible use of radioactive isotopes in the corrosion study.

After further general discussion the meeting was adjourned at 5:00 p.m.

TUESDAY MEETING, 12:30 P.M., FEB. 20, 1951, HOTEL COMMODORE, NEW YORK, N. Y.

Members Present:

J. R. Lientz, *Chairman*
S. J. Baisch
F. W. Flynn
John J. Goss
N. Shoumatoff
W. Smith
H. O. Teeple

Others Present:

L. C. Jenness, Chemical Engineering Committee, TAPPI
L. R. Thiesmeyer, J. R. Hart, J. H. Ross, W. Boyd Campbell, Douglas Jones — PPRIC Steering Group

This luncheon meeting was devoted exclusively to a presentation and discussion of the use of an IBM punched card system in the coding and recording of data accumulated through the use of the TAPPI questionnaire and field contacts by the Canadian task force.

After the discussion period, the group decided to work toward the completion of the following schedule:

1. Complete as quickly as possible the mill coverage in the United States.
2. Work up a satisfactory coding system by the first part of April.
3. Call a committee meeting during first or second week of April for consideration of coding and returned questionnaires. It would be desirable to have certain members, i.e., on coding, of the Canadian group present at this meeting.
4. Prepare a comprehensive report based upon IBM analysis of the data for submission to cooperating mills by early Fall, i.e., prior to the Engineering Conference in Savannah.

The meeting was adjourned at 2:20 p.m., by J. R. Lientz, *Chairman.*

Progress Report of the Alkaline Digester Corrosion Subcommittee

The subcommittee has made some significant progress since its organization a year ago. A questionnaire has been prepared and sent out to kraft and soda mills. A bibliography on the subject has been prepared which will appear in *Tappi* in the near future. Excellent liaison with the Canadian group studying alkaline digester corrosion has been maintained during the year.

It is to be noted, one of the initial functions of the committee was an attempt to acquaint the various alkaline pulping mills with the possibility that corrosion problems may exist and yet be unknown. Evidence was found in the returned questionnaires that this primary purpose has been achieved to a considerable extent. It was felt by the committee that even though an early solution to the digester corrosion problem was not easily forthcoming, at least if the mills ascertained the extent of their own problem, they would thus avoid to some extent the difficulties associated with operations under unrealized hazardous conditions.

With regard to the questionnaire, a few explanatory and/or apologetic remarks are in order at this time.

When the proposal was made to send out a rather detailed questionnaire inquiring as to the performance of past and existing digesters, it was decided to direct the questionnaires to the attention of top mill management. It was felt the problem was one of such magnitude that management would not only be interested but also be concerned in attempting to work out an answer. Unfortunately, some questionnaires were directed to people other than management and further, again unfortunately, some mills were inadvertently omitted. It is planned to correct both these situations within the next few weeks.

Through an oversight, questionnaires were sent out to Canadian mills which was not the intention of the committee. The reason for this was that the Canadian mills were embarking on a very ambitious program of their own. The committee, fortunate in finding itself subject to excellent cooperation with the Canadian group, felt whatever information acquired on the subject either in Canada or the United States should be exchanged according to existing liaison arrangements. The questionnaires returned by the Canadian mills have been summarized for comparison with the American mill questionnaires. However, the data will be forwarded to the Canadian group for its perusal and use.

Now as to the results indicated by the returned questionnaires, it should be noted that insufficient time and man power have prevented an exhaustive analysis of the data. Some results will be given but their true value may be somewhat limited because of incomplete analysis and mill coverage.

Fifty-four questionnaires were sent out and of these 32 were returned, including Canadian responses. The breakdown of the returned questionnaires is shown in Table I.

Table I. Mills Replying to TAPPI Digester Questionaire

	Kraft	*Soda*	*Total*
South	14	0	
North East	0	4	
North Central	4	0	
North West	3	1	
Canada	6	0	
Total returns	27	5	32
Total sent out U. S.[a]	35	8	43
Total U. S. mills[b]	59	20	79

Returns	32/54	60%
U. S. kraft coverage	21/59	36%
U. S. soda coverage	5/20	25%
U. S. alkaline coverage	26/79	33%

[a] Eleven were sent to Canadian Mills.
[b] Post's *Paper Mill Directory*, 1951 Edition.

The questionnaire data, presented below, will be divided into five groups: (1) kraft—stationary digesters, (2) kraft—rotary digesters, (3) soda, (4) Canadian, and (5) general comments.

It is not to be presumed that this is necessarily the most appropriate means of analyzing the data but it is the procedure to be followed in this instance.

Kraft—Stationary Digesters

In the various mills reporting, 187 digesters are represented. These include both replaced and existing digesters. Reported rates of corrosion range from 1 mil per year to 262 mils per year. Service life in terms of months is not especially useful since this is associated with corrosion allowance factors.

By and large the steels used are A-212 (70,000 TS) or A-285 (55,000 TS) with the digesters built to U-68 code.

Inspection of chemical and physical variables in the pulping operation indicates fairly typical conditions prevailing. No large discrepancies were noted.

One of the mills reporting corrosion rates showed data for a number of digesters. Some of these digesters were made of low-carbon, low-tensile steel (A89) and others were made of A70 (now A-285) firebox quality steel. It appeared enough data were available for a statistical analysis pertaining to the two steels. There were four rates shown for the A89 steel averaging 0.031 i.p.y. with a maximum of 0.037 i.p.y.

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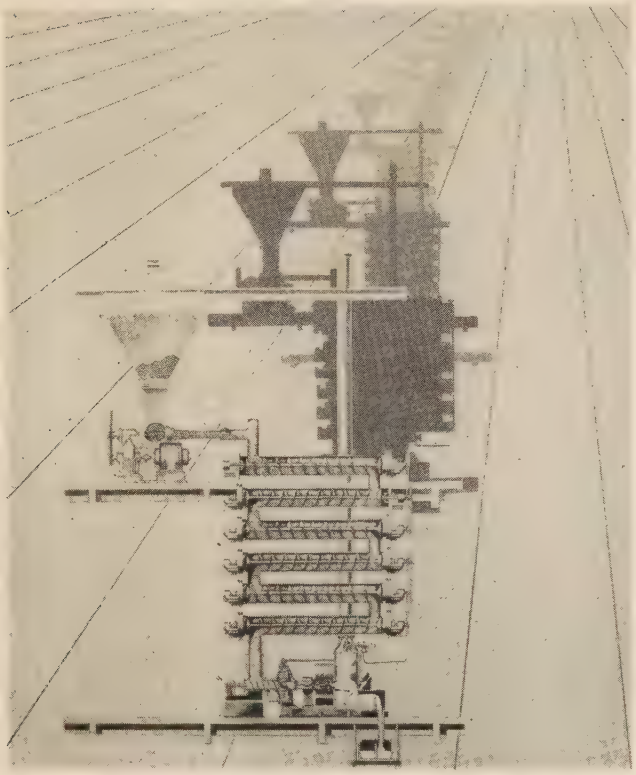

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and a minimum of 0.025 i.p.y. Analysis of the data showed the A89 steel to have significantly greater corrosion resistance, although the difference is only slightly in excess of the calculated estimate of error. It is important to note a statistical analysis of the data for the digesters made of old steels and newer steels (since 1940) in the case of the mill mentioned previously, showed no significant difference in over-all corrosion rates.

However, other important factors should not be ignored in considering these results. For example, the assumption that chemical and physical conditions did not vary significantly during the periods of time involved, in this case about 20 years. Another point is that the reported corrosion rates are based upon loss in wall thickness at the thinnest point in the digester. No information is available as to the method used for the thickness measurement nor how many readings were made nor the variation in these readings if more than one were made. It is to be noted that these findings are based on average corrosion rates over the life of the digesters and do not show any increase in corrosion rate during recent years on any one digester.

This latter fact is emphasized by data supplied by another mill reporting corrosion data for some 20 digesters. The average corrosion rate for these 20 digesters based upon whole life is 0.047 i.p.y. However, based upon current rates, i.e., metal lost between Audigage readings, the average is 0.091 i.p.y. (since 1947–48). One digester which showed an over-all rate of 0.030 i.p.y. is showing a current rate of 0.120. However, the over-all rates for three digesters installed in 1948 are 0.092, 0.075, and 0.142 i.p.y. These latter data seem to indicate current carbon steel is corroding at a faster rate and/or the operating conditions are more corrosive.

Kraft—Rotary Digesters

In the various mills reporting, including one Canadian mill, 73 digesters are represented, including those replaced and those existing. One mill reported corrosion rates from 63 to 94 mils per year. Other mills reported constant corrosion rates and increasing corrosion rates but numerical values were not given. Again, generally speaking, digesters were made of A-285, 55,000 tensile steel, using U-68 construction. However, some mills reported service life for Pintsch digesters. One mill reported no essential difference in corrosion rate of Pintsch digesters compared with A-70 (now A-285) digesters. Another mill reported serious pitting in digesters (A-70) installed since 1946 and 1948. This mill reported corrosion rates of 0.022 to 0.025 i.p.y. for digesters installed 1923–27 to 1946–48.

Inspection periods varying from two weeks to annual were reported.

Soda Digesters

In the various mills reporting, 32 digesters were represented. Corrosion rates from 5 to 14 mils per year are reported. Some mills reporting are operating on modified soda, i.e., up to 12 and 15% sulphidity. The latter mill reported a corrosion rate of 80 mils per year which corresponds, to some extent, with rates reported by kraft mills. One mill operating modified kraft reported a digester failure due to caustic embrittlement.

Most digesters were A-285, 55,000 TS, U-68 construction. The use of some hammer welded and riveted digesters was reported.

In summary, in straight soda or low sulphidity modified soda, corrosion of the digesters does not seem to be a problem.

Canadian

As was mentioned earlier, Canadian kraft mills were inadvertently solicited, eleven questionnaires being sent out. Of these, six were completed and returned. Two mills acknowledged receipt of the questionnaires and properly indi-

cated a preference for working with the Canadian Digester Group. One mill, which is a modified soda (flax and rag mill) is not readily comparable to other alkaline mills.

A Canadian mill, employing rotary digesters, has been grouped with those American mills also employing rotary digesters in the summary above. The four remaining mills which returned the questionnaires are summarized herewith. In these four mills, 58 stationary digesters are represented. Corrosion rates ranging from 55 to 100 mils per year are reported. Three of the four mills report increasing rates of corrosion. It is indicated that the Canadian mills are inspecting their digesters more frequently than are mills in the United States.

General

A few comments based upon reported items of information appear to be in order with reference to the use of alloy lined or clad digesters.

Six type 347 stainless lined digesters are reported and two have failed due to lining cracking. Two type 347 clad, one type 316 Cb clad, one type 316 ELC clad, and one type 410 clad digester have been reported. A corrosion rate of 0.005 has been reported for type 347 stainless steel and a corrosion rate of 0.084 i.p.y. has been reported for type 410 stainless clad.

One mill used a type 304 stainless steel lining in the bottoms of the cones of several digesters but removed them due to poor performance corrosion-wise. Another mill has used type 316 clad steel for lower cones with satisfactory performance.

One mill has installed a carbon brick-lined digester with satisfactory performance to date although it is probably too early for accurate evaluation. An Inconel-clad steel digester has recently been installed in one mill.

One mill has reported the recent installation of a field-applied Inconel lining in a rotary digester.

In general, based upon questionnaire data submitted to date, some difficulties have been encountered with both field and shop applied whole or partial stainless linings. Similar difficulties with alloy clad digesters have not been reported. On the basis of the experience of the one mill with type 410 clad steel digester, it appears this procedure does not provide a satisfactory solution to the digester corrosion problem.

In closing, it appears practical to enumerate certain desirable procedures to follow with respect to ascertaining the extent of digester corrosion:

Procedure for Existing Digesters:

1. Regular inspection at 6 to 12-month intervals.
2. At each inspection, check shell thickness with Audigage, by drilling, or some other suitable method, observing and recording pattern of wear, pitting, etc. Photographic records may be desirable.
3. Keep record of information obtained at each inspection and compare data with those obtained through previous inspections, thus obtaining a check on both current and over-all corrosion rates.

Procedure for New Digesters:

1. At time of installation, record data concerning type of steel used, coupon analysis of plates, steel plate manufacturer and digester fabricator, and type of code construction.
2. Before initial operation, check plate thickness, inspect welds and entire interior surface of the digester. Keep a complete record of thickness, visual surface condition observed, etc.

It is to be emphasized this first summarization of digester questionnaire data is probably not conclusive since time was not available to completely analyze and compare all items of data. It was felt by the committee, however, that the foregoing remarks and comments would be of considerable interest to those people concerned with alkaline digester corrosion.

H. O. Teeple, *Secretary*
Digester Corrosion Committee

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LOCAL SECTION ACTIVITIES

Reports of Meetings, Personnel and Events

Lake Erie

On Friday, April 20, fifty members of the Lake Erie Section of TAPPI heard a discussion of "Surface Treatments."

Vance Vallandigham of the Kelco Co., well known for his work on surface applications, presented a paper entitled "The Application and Effect of Surface Sizing." Mr. Vallandigham covered the two major types of sizing, the film former and the saturating type, as applied on the size press and calender stack of the board machine. His talk was illustrated with photomicrographs showing the effect on board surface of wet pressing and calendering followed by surface sizing at the calender stack. Mr. Vallandigham stressed as contributing to uniform surface application, good circulation across the calender box for even temperature of application and provision for prevention of foaming and low pickup. Mr. Vallandigham stated that calendering squeezes heated air from the intercellular spaces into the calender solution causing foam and also forces the calender application away from the surface of the sheet. The solution to this problem is to run the calender solution as cool as possible, preferably at 120°F., so that contraction of the heated air takes place thereby creating a vacuum to draw in the calender solution.

Paul Yoder of Pyroxylin Products, Inc., Paoli, Pa., covered "Protective and Decorative Coatings Applied from Organic Solvents." Mr. Yoder stated that solvent-type coatings had experienced an extremely rapid growth and traced their development back to spirit varnish still in use today for covers and labels, and probably the first solvent-type application. Some changes have taken place in these materials, such as substitutions of modified corn proteins for natural gums and the addition of plasticizers and waxes. Low cost, some water resistance, protection of the printed matter, and glossy appearance are some of the advantages of its use.

Nitrocellulose giving stronger and more flexible films than spirit varnish began to be used in 1920, followed by other cellulose derivatives, such as cellulose acetate and ethyl cellulose. Normally these materials are modified with resins which act as plasticizers and hardeners.

The next development in the production of raw materials came with the vinyl resins, vinyl acetate, and copolymers of vinyl acetate and chloride. Excellent thermoplastic properties made the vinyls popular immediately.

More recent developments used in paper coatings are the modified chlorinated and cyclicized rubber compounds, polyamides, alkyd, polystyrene, and polyethylene resins.

Equipment generally used in solvent applications includes the knife coater, equalizer bar and reverse roll coaters, and rotogravure. Rotogravure has increased considerably during the last few years with materials ranging from cellophane to clay coated board as raw stocks. One to 8 pounds per thousand square feet of film has been applied with proper choice of etched or knurled roll and coating solids.

L. to r.: William Schoenberg, P. H. Yoder, L. K. Burnett, V. V. Vallandigham, and W. O. Manor

Mr. Yoder outlined the properties of various resins, such as water vapor resistance, grease resistance, heat sealability, abrasion resistance, and others and concluded by stating that many of the materials were in short supply because of the war, the principal shortage being in solvents and modifiers with considerable short supply on rubber based materials, vinyls, and polyethylene.

Many interesting questions were raised during the discussion period following the talks.

During the business meeting, a revised constitution was submitted for approval by the members and a new slate of officers presented by the Nominating Committee.

Protective and Decorative Coatings Applied from Organic Solvents

P. H. Yoder

Members of the Lake Erie Section I am glad to have this opportunity to discuss with you the subject of Coatings Applied from Organic Solvents. Because of the growth which has taken place in the use of these coatings it is rather difficult in a short period of 25 or 30 minutes to more than give a brief description of the materials used for this purpose along with a résumé of the methods used to apply the coatings and the uses to which the end product is put.

Probably the first coating applied off the press where some solvent other than water was used was so-called spirit varnish. This material consisted of a solution of manila or some other naturally occurring gum in alcohol and in which the solids content at the point of application was from 35 to 40%. This type of material is still widely used, particularly in the coating of printed matter such as labels, book and catalog covers, and similar printed matter but the formulation has changed considerably. Instead of using a natural gum as the base, most spirit varnishes today are made from corn protein, known commercially as zein, modified with rosin derivatives such as ester gum and possibly a plasticizer and containing a small percentage of wax or heavy oil to improve the abrasion resistance. These coatings are relatively low in cost and perform the functions of protecting the printed matter, giving the surface a fair degree of gloss, and adding some water resistance.

With the advent of the commercial production, about 1920, of nitrocellulose containing a lower percentage of nitrogen than that in guncotton it was noted that stronger and more flexible films could be applied to paper than those laid down from spirit varnish. However, the viscosity of the first nitrocellulose of this type was quite high and, even though modified with resins and plasticizers, it was impossible to make a coating which at point of application contained more than 15% solids. About 1925 lower viscosity types of nitrocellulose became available and by using the lowest viscosity types, at some sacrifice of film strength, it became possible to build up the solids content to as high as 35 to 40% and apply the coatings on existing equipment. The production of other cellulose derivatives followed, first, cellulose acetate, then ethyl cellulose and cellulose acetate butyrate. In making coatings for paper with any of the cellulose derivatives, modifying materials are used. These modifying materials of a resinous character are rosin, esterified rosin and rosin acids, modified phenolic resins, paratoluol, sulfonamides, maleic acid modified ester gums, vinyl acetate, and many

others. Some of those resins have both a plasticizing action as well as hardening the coating. The most common plasticizers are phthalic acid derivatives, nondrying natural oils, such as castor oil, sebacic acid derivatives, citric acid derivatives, and organic phosphates. However, in connection with the packaging of foodstuffs, particularly if the coating is in direct contact with the packaged product, the list of modifying materials is narrowed down considerably to those materials which are free from odor and taste and are nontoxic. The solvents used with the cellulose derivatives are generally esters or ketones with aliphatic or aromatic hydrocarbons used as diluents.

The next important advance in the production of raw materials which could be used to advantage in paper coating came with vinyl resins. Vinyl acetate immediately was used in this field because of its excellent thermoplastic properties. Copolymers of vinyl acetate and vinyl chloride of varying acetate-chloride content are used for coating paper backed aluminum foil both for functional and decorative purposes.

Later, and particularly during World War II vinyl butyral was widely used for government packaging structures. Vinylidene chloride has also found its place in coating transparent films, kraft, glassine, and other types of paper. The common solvents for the vinyl acetate coatings are alcohol and lower boiling esters and ketones. The copolymers and vinylidene chloride are usually mixed with ketones with some aromatic hydrocarbon as diluent.

Other materials used to a lesser extent are rubber derivatives such as chlorinated rubber and cyclicized rubber. To utilize these materials to the best advantage they are usually modified with other resins and/or waxes. Solvents for these materials are generally either aliphatic or aromatic hydrocarbons or mixtures of the two types.

Recent developments in the raw materials that are used to some extent in paper coating include polyamides, styrenated alkyd resins, polystyrene, and polethylene.

The equipment generally used for the application of solvent applied coatings to sheets is that known as a varnishing machine. The sheet of paper is picked up by grippers on a drum of sufficiently large circumference to prevent overlapping. The coating is picked up by a rubber or composition roll, metered to another roll running in the same direction as the cylinder carrying the paper and at the same or slightly different speed to cause a shearing action. At the proper time the roll carrying the coating is moved into contact with the paper and the coating transfers to the paper surface. Coating weights of from $^1/_2$ pound to 4 or 5 pounds of dry film per thousand square feet may be applied by this method. After application the sheet is carried on tapes into a drying oven and dried for from 10 to 20 seconds at from 160 to 300°F. Coatings applied by this method must have a relatively low viscosity to prevent laid lines or ridges from building up.

For application to a continuous web there is a wider variety of methods, and either one or two sides of the web may be coated in one pass through the coating machine. The equipment used includes the knife coater, the equalizer bar type of coater such as that used in applying wax, the reverse roll coater, and rotogravure. The rotogravure method of application has increased considerably in the past few years and is now used to apply coatings on films such as cellophane, to paper such as glassine, coated litho, kraft, lightweight card stock, chip and news board, patent and clay coated board, and other stocks. By rotogravure using the proper etched or knurled cylinder coating weights of from $^1/_3$ of a pound to 2 or 3 pounds of dry film per thousand square

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P. H. Yoder

V. V. Vallandigham

feet may be applied from coatings containing from 18 to 30% nonvolatile. By other methods of application coating weights up to as high as 5 to 8 pounds per thousand square feet may be applied from solutions containing as high as 50 to 60% nonvolatile. In many cases the viscosity of lacquers or varnishes may be lowered to the point required for proper application by warming the coating to around 120 to 130°F., thereby eliminating the necessity for adding an excessive amount of thinner and aiding in keeping the coating on the surface.

In the label coating field spirit varnish is still the most widely used material. However, the amount of nitrocellulose lacquer used for all types of paper coating is increasing rapidly and other then spirit varnish, nitrocellulose lacquer is the most widely used of all coatings of this character. For other than general decorative purposes these coatings are used for some one or more functional properties such as water vapor resistance, grease and oil resistance, solvent or chemical resistance, heat sealability, abrasion resistance, and others. The coatings generally used where a good degree of water vapor resistance is required are nitrocellulose, chlorinated rubber, cyclicized rubber, or vinylidene chloride. Most cellophane is coated with a nitrocellulose lacquer modified to make the coating thermoplastic and containing a low percentage of wax for water vapor resistance. The same type of coating is used on glassine for the same reasons. For grease resistance, cellulose acetate, cellulose acetate butyrate, and coatings formulated from copolymer vinyl resins are used. Materials having good resistance to solvents and chemicals in general are the copolymer vinyls, chlorinated rubber, and cyclicized rubber types. For heat sealing properties vinyls, vinylidene chloride, polyamides, polyethylene, and cyclicized rubber are used. Mention was made earlier of the styrenated alkyd type of coating and since this is one of the newest types of materials a minute may be well taken to give it more than passing mention. This type of coating is applied from an aromatic hydrocarbon solution and to obtain the highest gloss should immediately be passed into an oven at from 275 to 300°F. for from 12 to 15 seconds. This baking produces a finish having a gloss almost equal to that obtained by the lamination of a transparent film such as cellulose acetate and which has excellent abrasion and solvent resistance. The weight of coating required is low—from 1 to $1^1/_2$ pounds per thousand square feet. The coating has a low viscosity so that on varnishing equipment it may be applied at as high an 45% solids. There are samples here of various types of packages and other paper products on which organic solvent applied coatings have been used.

Perhaps at this point a word or two about the supply situation on these materials would be of interest. There is no shortage at present of nitrocellulose but some of the modifying materials or solvents are rather difficult to obtain.

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Cellulose acetate is in fairly good supply but cellulose acetate butyrate and ethyl cellulose are on allocation by the producers and the situation will probably get worse. All vinyl resins are difficult, if not impossible to obtain for general use, and delivery on rated orders is slow. Materials based on rubber are in short supply and at present, highly priced. Polyethylene is required in large quantities for military uses and therefore is not too available. Spirit varnish is readily obtainable and so are certain types of polyamides. The supply of styrenated alkyds is limited.

Charter Meeting

On May 18 the Lake Erie Section sponsored a full-day meeting of the TAPPI Corrugated Containers Committee on "Corrugated Combining." The details of this meeting will be reported at a later date.

At a dinner meeting, attended by about 200 individuals the Section celebrated the reception of its charter as a local section from the national organization. Lewis K. Burnett of the Ohio Boxboard Co., Rittman, Ohio, presided as chairman.

The charter, gavel, and Section banner were presented to the Section by R. G. Macdonald, Secretary-Treasurer of the Technical Association of the Pulp and Paper Industry, New York, N. Y.

The Establishment of a Local Section

R. G. Macdonald

The present and past year has marked the occasion of the twentieth and fifteenth anniversaries of three local sections of the Technical Association. These anniversaries are milestones of which these sections have reason to be proud. They represent spans of years when the fortunes of these bodies have been in the hands of changing administrations. That they have survived has been a testimony of their value to their members and to the continued support of the local management in the industry.

Address given on the Occasion of the Presentation of the Charter Completing the Establishment of the Lake Erie Section of the Technical Association of the Pulp and Paper Industry, Cleveland, Ohio, May 18, 1951.

Presentation of Lake Erie Charter
L. to r.: L. K. Burnett, Wm. Hasselo, and R. G. Macdonald

On this occasion of formally presenting to the Lake Erie Section its Charter, and other symbols of its place in the Technical Association and the industry, it is a good time to review a little of the history of the association and its local sections.

The instigation and growth of the association reflects, to some extent, the growth of appreciation of the services of the technically trained man in the industry. Prior to 1915, when, the association was founded, there was a growing recognition of the need of technical men.

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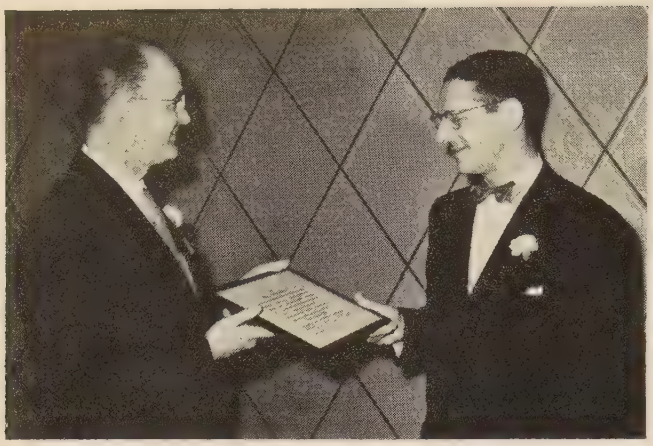

C. P. Spring (left) presents scroll to William Schoenberg

In 1908 we find the first public consideration of technical opinion insofar as it related to the future of the industry. At that time the House of Representatives conducted a thorough investigation of the wood pulp and newsprint paper industries. Shortly before this the Forest Products Laboratory had been established in Boston, and H. S. Bristol, Chief of the Wood Chemistry Section, was called upon before the House Investigating Committee with Arthur D. Little to testify. (Dr. Little was then the official chemist of the American Paper and Pulp Association.)

Dr. Bristol pointed out that since spruce wood was beginning to become scarce it might be a good idea to see if any other woods were suitable for papermaking. He had heard that basswood and willow had been used in the early days of the industry. The principal investigations had been made using the soda process, but few experiments had been made using the sulphite process. Since 1905 the Laboratory had found seven species that could be cooked by the sulphite process to make merchandizable pulp for newsprint.

Dr. Little reported that the most significant development of the year in papermaking was the serious and general inquiry all over the world for new sources of paper stock. He recommended that because of the growing shortages, attention should be given to the possibility of using flax, cotton, and other agricultural wastes.

The foregoing is cited to show the state of the art relative to pulp and paper technology in 1908. The technical work for the industry was being handled for the industry largely by government laboratories and private consultants. There were but few technically trained men employed by the industry, and these were used largely as plant engineers and executives.

There were a few technical men in the industry and they were, for the most part, members of the German Association of Cellulose Engineers and Chemists. At the meeting of this organization in 1914, at Berlin, Messrs. Mahler and Obermanns induced the German Association to establish an American Section.

When this proposal was discussed back in the States at a meeting of the Wrapping Paper Division of the American Paper and Pulp Association, it was decided not to form the German affiliate, but rather to organize a Technical Section of the American Paper and Pulp Association. This arrangement was carried out in 1915 and a section was formed. However, it was felt that more rapid progress would be made if the group was separated from its parent trade association and allowed to develop as a self-financed and administered body. This separation occurred in 1915.

From the beginning it was recognized that to serve its members most effectively consideration should be given to regional interests. As a result, at least once each year there has been

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a meeting of the Technical Association held in some manufacturing center away from New York City where the annual meetings are held.

There were some early attempts to get local organizations under way in the Miami, Connecticut, and Kalamazoo Valleys. With the exception of the latter, these attempts were unsuccessful. In Kalamazoo an organization known as the Paper Technologists Club had good support but was not directly affiliated with the Technical Association.

In 1928 an attempt was made to form an independent technical association on the Pacific Coast. This failed and as a result TAPPI was called in to organize a local section in 1929. Your Secretary was sent to the Coast to accomplish this and after ironing out a number of difficulties and misconceptions, the first local section of the association was organized on June 22, 1929, at Seattle.

This success was followed by the organization of the Lake States Section at Menasha, Wis., on Oct. 17, 1930, and the Delaware Valley Section in June, 1931. The Paper Technologists Club agreed to become the Kalamazoo Valley Section in 1931. In 1932 the New England Section was organized at Holyoke. The Ohio Section received its charter in 1935, the Empire State Section in 1938, the Maine-New Hampshire Section in 1945, and the Chicago Section in 1946. This month in Macon, Ga., a prospective section got under way.

On June 29, 1950, Bill Schoenberg wrote to me and advised that there was considerable interest among the personnel in the mills located in Northern Ohio, Southeastern Michigan, and Western Pennsylvania for the formation of a section of TAPPI since attendance at the nearest sections involved too much time for men to be away from their mills. Phil Cade, Past Chairman of the Ohio Section, had advised Mr. Schoenberg to get in touch with the Secretary of the association in regard to obtaining assistance in getting a group organized in the Cleveland area. The Secretary advised Mr. Schoenberg

F. D. Long, L. K. Burnett, and R. G. Macdonald

that the simplest way to start a new local group was to plan a meeting and invite all interested to attend. With some preliminary planning this first meeting could take care of most of the organizing details.

The first meeting was called on Oct. 7, 1950, at the Hickory Grille in Cleveland and showed the results of the great enthusiasm of the steering committee. The Association Secretary presided during the election of officers and turned the meeting over to Lew Burnett, of the Ohio Boxboard Co., as first chairman of an organization called the Lake Erie Papermaker's and Converters' Association.

The Association Secretary's next visit to the LEPCA was at its business meeting held at Barberton, Ohio, during the past summer. The continued enthusiasm and interest of the organization was reflected in the serious attendance to business of the members of the executive committee and members

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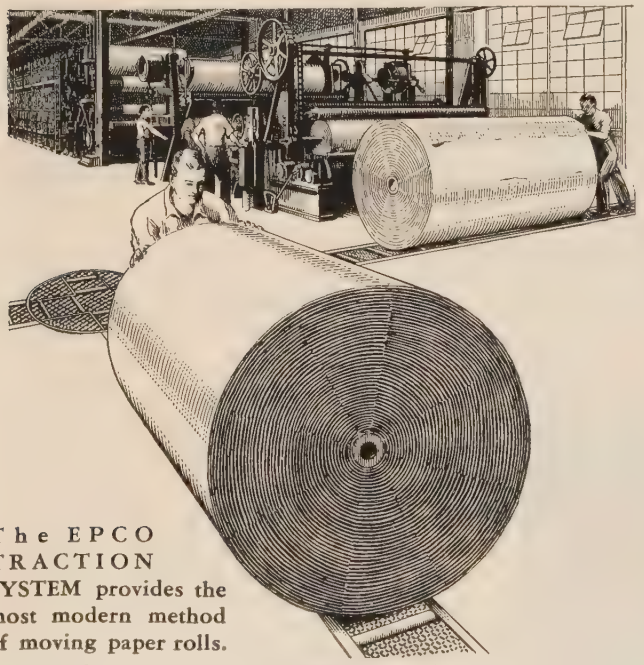

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of the subcommittees. Although there were opportunities for less serious pursuits the committee devoted much of the day to the administrative problems ahead. Their dedication to this objective led to an unusually fine series of meetings held during the current year, and when the petition for the establishment of the Lake Erie Section reached the national Executive Committee in February, 1951, there was every evidence that LEPCA was ready for local section status.

The present occasion is a ceremonial and is devoted to completing, with symbols, the action taken in February when the petition of LEPCA for a charter be granted to it as the Lake Erie Section of the Technical Association of the Pulp and Paper Industry was approved by the Executive Committee of the association.

On behalf of the Technical Association and its Executive Committee it gives me pleasure to present you with the Lake Erie Section Charter. The banner on display is a gift from the association to the section and this gavel is given to your chairman to be used by him and his successors as a symbol of their responsibility, to the section, the association, and the industry in supplying the leadership that will always be needed to make worth-while contributions to the technical advancement of the pulp and paper industry and to the region served by the Lake Erie Section.

Richard P. Price, Vice-President of the Hammermill Paper Co., Erie, Pa., represented Kenneth P. Geohegan, President of the Association, who was unable to attend due to illness. Mr. Price extended the greetings of the Executive Committee to the Section.

In recognition of their zeal and enthusiasm in organizing and handling the affairs of the Section since it was formed as the Lake Erie Papermaker's and Converters' Association, C. P. Spring of the Chase Bag Co., Chagrin Falls, Ohio, on behalf of the Section presented a testimonial scroll to William Schoenberg, Secretary, and an aluminum cocktail set to Lewis K. Burnett, Chairman of the Section.

F. D. Long, of the Container Corp. of America, Chicago, Ill., and Chairman of the TAPPI Corrugated Containers Committee thanked the Section Officers for sponsoring the Corrugated Combiner Conference and pointed out some of the unsolved problems of corrugated box manufacture to the one hundred or more corrugated supervisors present. He also outlined some of the future plans of the committee.

At the business meeting of the Section the following officers were elected:

Chairman: William Hasselo, Container Corp. of America, Cleveland, Ohio.
1st Vice-Chairman: Joseph F. Thompson, Minerva Wax Paper Co., Minerva, Ohio.
2nd Vice-Chairman: Russell L. Lewis, Ohio Boxboard Co., Rittman, Ohio.
Secretary: Lynn E. Rolig, Ohio Boxboard Co., Rittman, Ohio
Treasurer: William Schoenberg, Lord & Schoenberg, Cleveland, Ohio.

Executive Committee:
L. K. Burnett, Ohio Boxboard Co., Rittman, Ohio.
Arthur Cheely, Hankins Container Co., Cleveland, Ohio.
David N. Cooper, Buckeye Ribbon & Carbon Co., Cleveland, Ohio.
Leonard R. Gwaltney, Ohio Boxboard Co., Rittman, Ohio.
Richard Jones, Sinclair & Valentine Co., Rittman, Ohio.
W. O. Manor, Consolidated Paper Co., Monroe, Mich.
J. Noll, Monroe Falls Paper Co., Monroe Falls, Ohio.
Dennis Reidy, Gair Cleveland Containers, Cleveland, Ohio.
David Shotwell, International Printing Ink Co., Cleveland, Ohio.
C. Peter Spring, Chase Bag Co., Chagrin Falls, Ohio.
George Traub, Traub Box Co., Cleveland, Ohio.

The speaker of the evening, George E. Fields, Technical Service Manager for Plastic Materials, B. F. Goodrich Chemical Co., Akron, Ohio, gave an interesting talk on "Development Requires Cooperation." Mr. Fields' address will be published in a later issue of *Tappi*.

R. L. Lewis, *Publicity Chairman*

Southeastern Pulp and Paper Society

This first meeting of the Southeastern Pulp and Paper Society was held in Macon, Ga., on the evening of May 4, at the Dempsey Hotel.

After dinner, G. C. Kimble, Union Bag Corp., acted in the capacity of Meeting Chairman, and first introduced H. A. Kidd, Resident Manager of the Macon Kraft Co., who welcomed the group to Macon, and extended an invitation to visit the Macon kraft mill the following morning. Mr. Kimble then reviewed the background of developments leading to the formation of the society. His remarks indicated that in the recent past there had been considerable interest along the lines of forming a TAPPI local section in this area, and in this connection, the management of mills had already indicated their interest and willingness to send employees to meetings. Mr. Kimble then discussed the requirements which would have to be met to eventually become a TAPPI Local Section; he also indicated that the area under consideration was embraced by Charleston, S. C., Macon, Ga., and Palatka and Jacksonville, Fa. Announcement of the next meeting, to be held in Brunswick, Ga., on Sept. 14, 1951, was made. At this meeting, permanent officers for the next year will be elected, and proposed articles of organization voted upon.

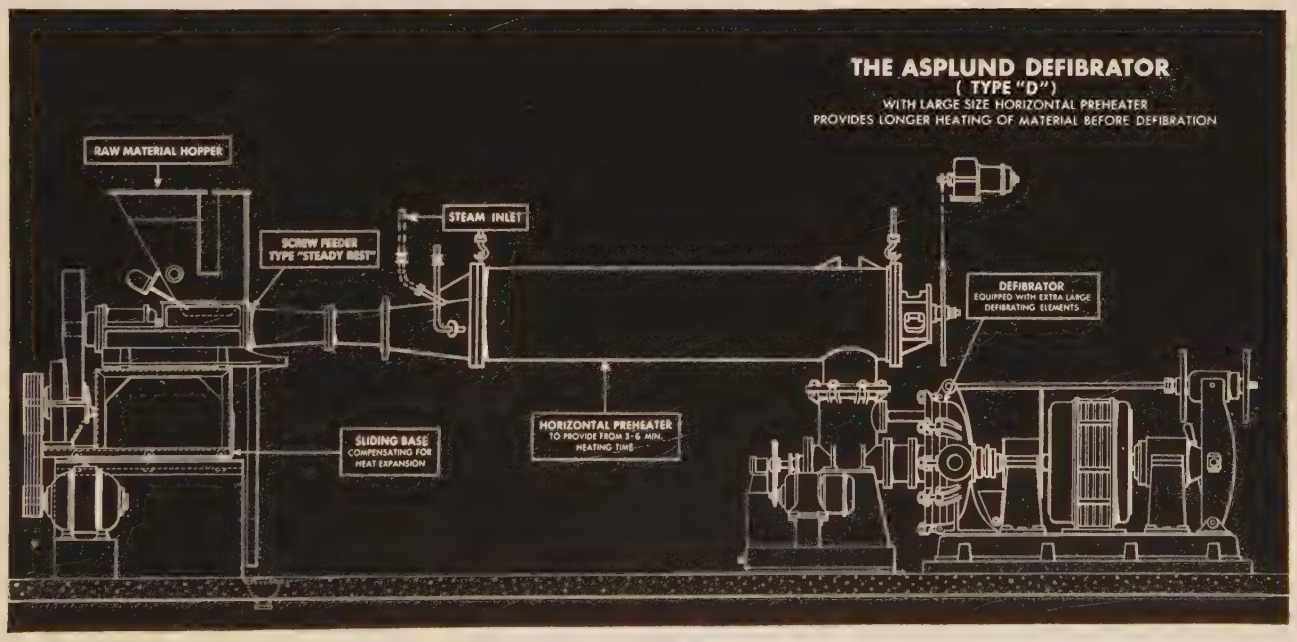
Robert R. Fuller, Gulf States Paper Corp., who was next introduced, reminded the group of the forthcoming National Alkaline Pulping Conference, to be held in Richmond, Va., on Sept. 26, 27, and 28, 1951.

The meeting was then turned over to William Ebersole, Macon Kraft Co., the Program Chairman, who introduced R. G. Macdonald, Secretary of TAPPI. Mr. Macdonald talked on the formation of local sections, and the advantages to be gained by affiliation with TAPPI. He also commented very favorably on the very good turnout to the first meeting.

G. W. E. Nicholson, Herbert A. Kidd, and R. G. Macdonald

Mr. Macdonald was followed by Sam Rose, Chief Meterman, of the Macon Kraft Co., with a paper entitled, "As a Meter Man Sees It," dealing with some of the present-day problems of operating an instrument department.

The closing speaker was G. W. E. Nicholson, Vice-President of the Union Bag Corp. Mr. Nicholson reminisced on his experiences after many years working closely with TAPPI. He then discussed expansion trends throughout the North American continent, emphasizing that the greatest amount of expansion was developing in the Southeast. He also discussed newer pulping procedures, equipment, and wood utilization. After his talk, Mr. Mortenson from the floor encouraged all present to take advantage of discussion periods in future meetings. William Childs, also from the floor, asked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Mr. Nicholson for his opinion on the future of high-yield kraft types. Mr. Nicholson's response indicated that such pulps are being given increasingly more consideration.

G. E. SCOFIELD, *Temporary Secretary*

Adams, Claude M., Southern Paperboard Corp., Savannah, Ga.
Allemore, N. F., St. Joe Paper Co., Port St. Joe, Fla.
Anderson, Robert P., St. Regis Paper Co., Pensacola, Fla.
Barkley, M. B., Southern Corp., Charleston, S. C.
Barrier, J. J., Robert & Co., Atlanta, Ga.
Blondheim, C. L., St. Marys Kraft Corp., St. Marys, Ga.
Boyd, Stanley J., Sonoco Products Co., Hartsville, S. C.
Brown, Wilson F., University of Florida, Gainesville, Fla.
Charbonnier, H. Y., Union Bag & Paper Corp., Savannah, Ga.
Childers, Ronald W., Macon Kraft Co., Macon, Ga.
Childs, William A., Jr., Container Corp. of America, Fernandina, Fla.
Clapp, L. L., St. Regis Paper Co., Pensacola, Fla.
Clark, C. L., West Virginia Pulp & Paper Co., Charleston, S. C.
Cook, F. C., Brunswick Pulp & Paper Co., Macon Kraft Co., Macon, Ga.
Crowe, Lewis M., Jr., M.-H. Regulator Co., Atlanta, Ga.
Dunn, T. T., Union Bag & Paper Corp., Savannah, Ga.
Dykes, Doyle F., Macon Kraft Co., Macon, Ga.
Ebersole, W. M., Macon Kraft Co., Macon, Ga.
Felton, Andy P., International Paper Co., Georgetown, S. C.
Fluck, A. F., West Virginia Pulp & Paper Co., Charleston, S. C.
Fretz, Mark E., J. M. Huber Corp., Huber, Ga.
Fuller, Robert R., Gulf States Paper Co., Tuscaloosa, Ala.
Goodwin, Lloyd E., Macon Kraft Co., Macon, Ga.
Green, Curtis E., Link Belt Co., Atlanta, Ga.
Guest, Karl M., National Container Corp., Jacksonville, Fla.
Hartford, C. E., Union Bag & Paper Corp., Savannah, Ga.
Harvin, R. L., Univ. of Florida, Gainesville, Fla.
Henderson, W. W., Henderson & Sons, Pensacola, Fla.
Homans, Roy, Brunswick Pulp & Paper Co., Brunswick, Ga.
Huber, D. A., Huber Feltex Co., Toccoa, Ga.
Hudson, Russell T., Union Bag & Paper Corp., Savannah, Ga.
Hughes, W. F., J. E. Sirrine Co., Greenville, S. C.

C. W. E. Nicholson addresses the Southern Pulp and Paper Society

James, John W., Gulf States Paper Corp., Tuscaloosa, Ala.
Kagey, L. B., Huffman-Wolfe Co., Atlanta, Ga.
Kennedy, Larry, M.-H. Regulator Co., Atlanta, Ga.
Keough, John E., Hercules Powder Co., Atlanta, Ga.
Kidd, Herbert A., Macon Kraft Co., Macon, Ga.
Kimble, G. C., Union Bag & Paper Corp., Savannah, Ga.
Kirkland, John S., Macon Kraft Co., Macon, Ga.
Klein, Louis A., Gulf States Paper Corp., Tuscaloosa, Ala.
Klein, Maurice, Union Bag & Paper Corp., Savannah, Ga.
Krebs, Edward D., Union Bag & Paper Corp., Savannah, Ga.
Lester, I. L., Georgia Kaolin Co., Dry Branch, Ga.
Lewis, John G., Rayonier Inc., Fernandina, Fla.
Lientz, J. R., Union Bag & Paper Corp., Savannah, Ga.
Luker, W. D., Union Bag & Paper Corp., Savannah, Ga.
Mahan, R. C., Hudson Pulp & Paper Co., Palatka, Fla.
Mappas, Julius, West Virginia Pulp & Paper Co., Charleston, S. C.
May, Ben F., Gulf States Paper Corp., Tuscaloosa, Ala.
May, J. A., Macon Kraft Co., Macon, Ga.
Meakin, H. W., J. E. Sirrine Co., Greenville, S. C.
Millman, N., J. M. Huber Corp., Huber, Ga.
Moon, D. G., J. E. Sirrine Co., Greenville, S. C.
Morris, John, Union Bag & Paper Corp., Savannah, Ga.
Mortenson, A. O., St. Regis Paper Co., Cantonment, Fla.
Murdock, Harold R., Robert & Co. Associates, Atlanta, Ga.
Macdonald, R. G., TAPPI, New York, N. Y.
McCall, F. S., Union Bag & Paper Corp., Savannah, Ga.
McClane, J. Huston, Hercules Powder Co., Atlanta, Ga.
McIntosh, Wm., Jr., Southern Corp., Charleston, S. C.
McNeil, J. E., Container Corp. of America, Fernandina, Fla.
Nicholson, G. W. E., Union Bag & Paper Corp., New York, N. Y.
Pace, T. Proctor, J. E. Sirrine Co., Greenville, S. C.
Parrino, Anthony J., Macon Kraft Co., Macon, Ga.
Pineo, M. B., Brunswick Pulp & Paper Co., Brunswick, Ga.
Plumlee, J. Carl, Macon Kraft Co., Macon, Ga.
Price, T. D., Stevens Fire Brick Co., Macon, Ga.
Ralston, John M., Jr., Union Bag & Paper Corp., Savannah, Ga.
Ray, H. E., Georgia Kaolin Co., Dry Branch, Ga.
Reynolds, George W., Macon Kraft Co., Macon, Ga.
Richter, R. C., St. Marys Kraft Corp., St. Marys, Ga.
Rippberger, C. C., Rayonier Inc., Fernandina, Fla.
Robson, Horace T., Union Bag & Paper Corp., Savannah, Ga.
Rogers, Charles N., Sonoco Products Co., Hartsville, S. C.
Root, E. M., The Black-Clawson Co., Decatur, Ga.
Rose, S. W., Macon Kraft Co., Macon, Ga.
Rucker, Claude L., Jr., Container Corp. of America, Fernandina, Fla.
Ryan, B. M., Asten-Hill Mfg. Co., Philadelphia, Pa.
Sawyer, Marvin, Container Corp. of America, Fernandina, Fla.
Scofield, George E., Rayonier Inc., Fernandina, Fla.
Seymour, George W., Brunswick Pulp & Paper Co., Brunswick, Ga.
Shannon, W. P., Macon Kraft Co., Macon, Ga.
Sim, Ian P., International Paper Co., Georgetown, S. C.
Simmons, W. B., Macon Kraft Co., Macon, Ga.
Simpson, A. D., Macon Kraft Co., Macon, Ga.
Small, T. W., Sprout Waldron Co., Muncy, Pa.
Smith, C. L., National Container Corp., Jacksonville, Fla.
Smith, William H., III, Southern Paperboard Corp., Savannah, Ga.

R. G. Macdonald speaking at the Macon meeting

Talley, W. R., Macon Kraft Co., Macon, Ga.
Thompson, L. A., Hercules Powder Co., Atlanta, Ga.
Upsone, James R., Union Bag & Paper Corp., Savannah, Ga.
Vogelsbert, Robert W., Moffatt Bearings Co., Atlanta, Ga.
Waldrop, T. W., Republic Flow Meters Co., Atlanta, Ga.
Watkins, H. H., J. E. Sirrine Co., Greenville, S. C.
Whelan, J. A., Macon Kraft Co., Macon, Ga.
Whiteside, George H., Container Corp. of America, Fernandina, Fla.
Whitley, J. B., J. M. Huber Corp., Huber, Ga.
Woolley, W. H., J. E. Sirrine Co., Greenville, S. C.
Wright, C. W., Hudson Pulp & Paper Corp., Palatka, Fla.

A Local Section in the Making

R. G. Macdonald

On this the first regular meeting of the Southeastern Pulp and Paper Society it may be presumptive of the speaker to infer that he is talking to a future local section of the Technical Association. Presumptive, in the first place, because the association itself does not take the initiative in promoting the formation of sections and, in the second place, because a group such as this in establishing itself assumes a title that does not suggest in any way that it is embarking on an apprenticeship in preparation for any future change in status.

One group in the industry started out 10 or more years ago in the way that your organization is doing today. Then, as now, I had the privilege of speaking on the program of the first meeting. Then, and to date, it has felt that certain benefits were to be derived by maintaining an independent status. It has got along quite well over the years and presumably will continue to do so.

In contrast, later this month, on May 18 at Cleveland, Ohio, another organization of a similar type will experience the ceremony of receiving a charter from TAPPI formalizing its establishment as the Lake Erie Section. In the recent past, this organization was known as the Lake Erie Papermaker's and Converters' Association. A few years ago our present Chicago Section was known as the Chicago Professional Paper Group.

Several years ago, when a number of pulp and paper mills were built along the South Atlantic Coast, an organization such as yours was started. It was known as the Southern States Pulp and Paper Club. It had the best of intentions but its short history indicated that it was premature and lacked some of the assets that a society such as this must have if it is to survive year in and year out.

Although the formation of an independent local society may seem to be somewhat ritualistic in nature, it appears to represent the proper procedure insofar as the national organization

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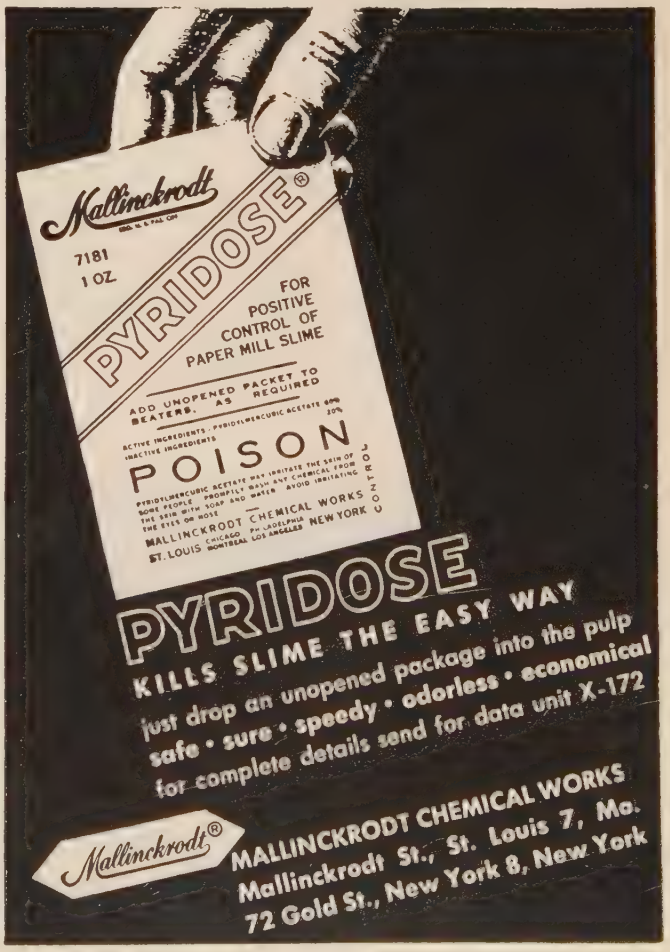
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is concerned. Three basic characteristics for future association local sections appear to be important.

The expectation of survival is very important. This expectation is greatest when a local group has competent leadership in the present and foreseeable future and if that leadership and the program that it presents has the approval and confidence of the management of the industry.

One reason why the national organization plays a restrained part in the early days of an organization such as this is because the local group needs to develop and exhibit a power of survival. Therefore, there is no need to provide for time of weaning. Rather it is a case of jumping off the dock into the branch and sinking or swimming from the start.

This responsibility on the part of the local leaders calls for extra effort and an adequate amount of preparation. These qualities were outstanding in the cases of our Chicago and Lake Erie groups. The net result was rapid progress and the demonstration of evidence of fitness much sooner than might be expected. In fact, in the case of the Chicago Professional Paper Group the progress was so satisfactory that some of its members were inclined to forego the affiliation with the association. More than the usual amount of time was required for it to drop its original name and limit its designation as the Chicago Section of TAPPI.

There are certain advantages, however, in a group such as this eventually becoming a section of the association. Times change and the aforementioned power of survival can be weakened by unforeseen circumstances. More than one of our most successful sections have at times found themselves in the doldrums. Such things as wars, depressions, internal politics, changes in leadership, irresponsibility, and other influences play their parts. Some of our sections have been reduced to almost complete passivity but in every case, to date, have been revived in comebacks that made them much stronger organizations.

The officers of the association try to visit every section every year—not too often, but often enough to observe their "interest quotient." In my own case I find it important to devote most attention to sections that appear to need encouragement. I attended a section meeting recently and someone asked me if there was anything wrong with it. I advised him that there was nothing wrong. I was present, first, because I received a personal invitation to attend and second, because I wanted to have the personal pleasure of attendance.

In the year to year operations of a section, finances are important. A certain amount of income is available usually, but not always, from local member dues. This is great or small depending on how many individuals are willing to become dues-paying members. After a section has been formed it automatically becomes eligible to receive financial support from the national organization. The section is entitled to receive a 10% rebate of the dues that its members pay to the association, provided that such national members are in good standing both in the association and the section.

At the meeting of the Executive Committee of the Technical Association held in February of this year two other forms of special financial assistance were approved; one to enable each section, if it so desired, to hear some outstanding cellulose scientists who will be in this country in connection with the World Chemical Congress in the fall; and the other, a fund was made available also to provide assistance to sections that needed aid in financing the attendances of speakers of their own choice.

The importance of its local sections to the association is made manifest by the invitation extended to section officers to attend the annual and other meetings of the Executive Committee. Every effort is made to enable section officers to become familiar with the current problems and administration of the association. At the annual meeting the item of local sections, in general and each local section, in particular, has prominent place on the meeting agenda.

Each year the President appoints an official representative of the Executive Committee to each local section. He is the principal liaison officer between the two organizations. It is his job to become personally acquainted with the section and to bring to the attention of the Executive Committee such legislation as may be in order to improve this relationship. In turn, he makes known to the section officers the wishes of the national body.

In addition there is a subcommittee of the national Executive Committee that devotes itself at all times to local sections and meets officially with the section officers in February to discuss mutual problems. The work of this committee brought into being the Magna Carta entitled "Local Section Organization," which appears in each volume of the *TAPPI Year Book*. Past chairmen of this committee worked hard to prepare this and although it appears to be the same from year to year it exhibits constant and increasingly minor changes in each succeeding edition.

The section officers have taken considerable advantage of these liaison arrangements and in the last year or two the association itself has begun to make known its desires. Currently these consist of urging sections to take a more constructive part in the association activities through the formation of special work committees that can contribute to the national program. Specifically, each section has been asked to organize Mill Routine Control and Data Sheet Committees, the chairmen of which to be members of a national committee devoted to these objectives. In the past, sections have been asked to devote at least one meeting to a strictly engineering program and another to a consideration of routine testing procedures. It is felt that both of these objectives can make maximum progress at the local section level. As time goes on and sections become more interested in tangible accomplish-

ments other chores will be offered, all of which will enable sections to do something definite for the well-being of the pulp and paper industry.

I have devoted this talk to some of the things that a group such as this should consider as it approaches a local section status. From the standpoint of each individual the group offers many things of importance, not the least of these being the opportunity of becoming better acquainted with each other. It provides an excellent opportunity for each of you to improve your status in the industry. I hope that the organization will give a large number of you something to do. There is much to be done. Aside from special assignments there is the real opportunity to express yourself at these meetings. The important thing about each of them are the subjects to be discussed. When these are announced give them some thought and when the opportunity arrives get on your feet and say something. At some time during the meeting get on your feet anyway. You will have to say something or you will look very silly. Do not be afraid of sounding silly. If you have devoted some time to preparation you will sound more rational but one of the main purposes of these meetings is to give you a chance to "sound off." Whether you sound good or bad to others I can assure you that you will look back at the meeting in which you participated as one that was very good.

In closing let me say that your steering committee has done an excellent job in obtaining the good will of your management toward your venture into local organization. The general plans for the future are good. I hope that "under your own steam" you will support your Society officers and let them know that you will guarantee their faith in you by going beyond the call of duty or even their request in making this the outstanding local organization in the industry.

As a Meterman Sees It

S. W. Rose

A great amount of technical work has been done by industrial concerns, instrument companies, and technical groups in solving specific measurement and control problems. Progress along this line has forced the instrument companies to build new and more complicated mechanisms. The problem of the instrument crew supervisor is how to use these advanced designs in his plant to improve quality and increase efficiency; also, how to keep his personnel abreast of advances that are made.

To solve his problems he must have enough technical knowledge to make correct decisions, and have a great deal of curiosity about everything in the industry. In fact, he may be considered a curiosity by some people because he is inclined to be too methodical, and is always chasing that unattainable thing—perfection. But, this man can help you; and you can help him.

S. W. Rose, Chief Meterman, Macon Kraft Co., Macon, Ga.

Back in the "good old days" there was very little exchange of ideas between mills, and technical progress was slow. Today, we will agree that no one person or mill does everything better than the other fellow, so ideas are freely exchanged and more progress is made.

The same principle holds true for instrumentation within your industry. Greater progress will be made through an interchange of ideas between instrument men. They should be encouraged to take part in groups such as this, so they will have a better opportunity to discuss their problems.

From experience picked up in his everyday work, your meterman is in a position to know the good points of the various types and makes of instruments, as well as their limitations. He has learned very definitely that, "All that glitters is not gold." Two instruments of different types or makes may be able to do the same job, but one may take twice as much maintenance as the other. You can take advantage of his experience by giving him the final decision on specification details for new instruments. After all, you make him responsible for their installation and maintenance!

Not so many years ago, instruments were relatively simple in design; in fact, they consisted mostly of pressure and temperature recorders, with a few flowmeters here and there. With those conditions, needs for shop facilities were not pressing.

But those days are gone. Instruments in a modern mill are a great deal more complex, and can be maintained only by skillful use of various tools and test equipment. A good job requires more than a screwdriver, pliers, and a bench located in a dusty out-of-the-way place where water drips down your neck. Has your meterman been given adequate shop facilities, tools, and test equipment?

No one can design a standard shop that will be satisfactory for every mill. Needs vary depending on conditions. But it is hard for today's meterman to see the justification for management and designers to spend large sums for instruments when they build or remodel a mill, and then make no provision for maintenance facilities to get the most out of their investment.

Regardless of the facilities provided, the biggest problem facing the instrument supervisor is the training of his men. This holds true in both the new mill and in the older mill which is trying to stay in tune with the times.

Sometimes members of the meter crew are called mechanics. A good meterman certainly must be a good mechanic, but he must also be a good troubleshooter. This involves, first, deciding whether the trouble is caused by the instruments; and, second, (if it is instrument trouble) finding what part of the instrument system has failed. In present-day instrumentation, it is harder to find the trouble than to make the actual repairs.

L. to r.: William Martin, Arthur Thurn, R. D. McCarron, Donald Goodman, H. A. Smith, C. E. Brandon, Richard Morris, and D. M. Yost

In large mills, and in some other industries, it is becoming the practice to have men specialize in one branch of instrument work, such as control valves, pneumatic control, flow-metering, or electronics. But this isn't practical in most mills, even though all types of work are done. The instrument man must be able to do every kind of work that is required.

Generally, we start with a high school graduate. This man should have made good grades in mathematics, and should have done well on a mechanical aptitude test. If he has a normal amount of the desire to succeed, he can learn the rest by study and experience.

The first, and highest hurdle is to get this man interested in becoming a good meterman. The desire must be strong before he will be willing to put forth the extra effort and study necessary to obtain the basic knowledge of physics, chemistry and electricity on which all of his training will be based. It will help if we make him realize that we intend to make him a good meterman and that we won't be satisfied for him to stay just a good helper.

The method of training cannot be standardized due to the wide range in sizes of mills and types of training facilities available. A few are fortunate enough to have night schools nearby, and that may simplify things considerably. But most of us have to develop our own training program.

It is felt that it pays to hold 2-hour on-the-job classes once a week for the new men, at least for the first year. In connection with the classes he does a certain amount of outside study and actually hands in written work. During this time he learns the essential basic theory in its most practical form, and that is tied in as strongly as possible with his work in the mill. He learns the "why" of a great many things and gets "cocky" because all of the mysteries are unfolding.

Soon after this, another reaction sets in. It happens to all of us sooner or later. He finds that the more he learns, the more there is to be learned. At this point he really goes to work to learn the job and be a good meterman, or he gives up and will never be a good one.

A leading correspondence school is now offering a course in instrumentation. This can be very helpful when used as an accessory to his job training.

The supervisor can be with the trainee or helper only at intervals, so most of his practical training must come from the journeyman. The journeyman should be made to realize that he is expected to teach his helper as much as possible. It will be wise to place the helpers on a rotation system among the journeymen, as they will learn some additional "trick of the trade" from each one.

However, no matter what training method is used, the helper will need two things from his supervisor: plenty of encouragement, and a firm nudge from time to time.

Most metermen keep a question in the back of their minds all the time: "Is that instrument doing any good?" Sometimes the question can be answered in terms of dollars and cents; at other times it is hard to figure in those terms. But there is one sure way to find the answer.

Every instrument is a piece of manufactured equipment subject to breakdown. If an instrument does fail and the operator or department supervisor calls immediately for a meterman, that instrument was doing some good. If no one reports the failure, the instrument was doing no good and should be removed.

So next time you get a meterman out of bed at 2:00 a.m., don't feel too badly. You have answered a question in no uncertain terms.

Ohio

The Ohio Section held its April meeting on Tuesday, April 10, at the Manchester Hotel in Middletown, Ohio.

The 115 members and guests present were treated to a very interesting motion picture and lecture demonstration on the use of color. The program was presented by O. C. Holland of the International Printing Ink Co. Mr. Holland's program included a background film illustrating the use and simple principles of color, and the manufacture of colored inks. Following the presentation of the film, Mr. Holland vividly illustrated the Munsell Color System and its use in properly designating the hue, chroma (or strength), and value (lightness or darkness) of a given color. The proper selection of colors to withstand specific conditions of light exposure, acidity, and alkalinity was discussed; and very interesting demonstrations of the correct usage of color for decoration were presented.

O. C. Holland

Donald Goodman, Ohio Section Chairman, presided at the meeting. The program was arranged by Phillip Evanoff.

May 10 Meeting

A large attendance of 210 were present at the Annual Meeting of the Ohio Section on May 10, 1951, to elect officers for the coming year, and to enjoy an evening of fellowship and entertainment.

TAPPI's National President, Kenneth P. Geohegan, was presented a wrist watch by the Ohio Section. Since Mr. Geohegan could not attend the meeting in person, the presentation of the symbol of esteem was made to him through G. H. Pringle, Vice-President, by the Ohio Section Chairman, Donald Goodman.

Officers for the 1951–52 season were elected in a business meeting. H. A. Smith was elected Section Chairman. Mr. Smith has been active in TAPPI affairs for a number of years and has served as Vice-Chairman of the Ohio Section for the past year. In the 1949–50 season Mr. Smith filled the vital post of program chairman.

Other officers elected are as follows:

Vice-Chairman: C. E. Brandon.
Corresponding Secretary: William Martin.
Recording Secretary: Richard Morris.
Treasurer: R. D. McCarron.

Members elected to the Executive Committee included: Paul Clark, Donald Goodman, Arthur Thurn, P. S. Cade, and D. M. Yost.

A full program of entertainment was arranged by William Martin. In place of the customary speaking program, the TAPPI men enjoyed a lively and interesting series of professional entertainment acts featuring song, dance, and juggling numbers. All agreed that the program was a memorable one.

The meeting was preceded by a cocktail party sponsored by the Shartle Brothers Machine Co. Members and guests enjoyed cigars furnished through the courtesy of William Biven of the Cincinnati Rubber Co.

M. G. Lyon, *Recording Secretary*

Kalamazoo Valley

The Kalamazoo Valley Section met in Kalamazoo, Mich., on May 3, 1951.

This meeting was devoted to the TAPPI Kalamazoo Valley Section Award. On behalf of the Section, Stephen Kukolich of the Lee Paper Co. made the award to Wilber Kite of Western Michigan College for having the highest scholastic average in his class in the Pulp and Paper School.

Mr. Kite accepted the award and introduced his classmates who discussed briefly their senior thesis. The students and their thesis subject were as follows:

Donald Huyser, "Dewaxing Waste Papers."
Wyman Uhl, "Brightness Testers."
Raymond Wagner, "Elastometers and Beater Retention."
Roger McVicker, "The G. E. Puncture Tester."
Elton Krogel, "Water Resistant Stock Coatings."
William Noel, "Variations in Yield in Deinking."
Edward Stephenson, "Enzyme Converted Starches."
Wilber Kite, "Deinked Stock—Opacity vs. Bleaching."

June 7 Outing

On June 7 the Section held its annual "Fun Day," at the Gull Lake Country Club in Kalamazoo.

A. T. Luey, *Recorder*
Sutherland Paper Co.

Pacific

Pacific Section's Annual Shibley Award Contest attracted a record attendance of over 200 to the meeting in Longview, Wash., on the afternoon of April 13, 1951. This year's contest was under the direction of Walter F. Holzer, Past-Chairman of Pacific Section and the newly elected member of the Executive Committee of TAPPI.

Four papers were presented in the 1951 competition, any one of which could have been considered for the award. In fact the Judging Committee, finding itself unable to choose between two papers, finally granted duplicate awards to Carter A. Watson, Puget Sound Pulp & Timber Co., Bellingham, Wash., for his paper "Sources of Wood Dirt in Unbleached Pulp" and to William F. Cyrus, Crown Zellerbach Corp., West Linn, Ore., for his paper on "Photographic Standards for Dirt Control."

The other contestants were John L. McClintock, Jr., Pulp Division, Weyerhaeuser Timber Co., Longview, Wash., who presented a paper entitled "Special Problems in the Operation of a MgO Base Sulphite Acid Plant" and K. M. Shold, Crown Zellerbach Corp., Port Townsend, Wash., who presented "Seam Adhesives for Multiwall Bags."

Approximately 50 students and faculty representatives from the colleges and universities in the area were guests of Pacific Section for the Longview meeting. The students were taken on conducted tours of the Weyerhaeuser and Longview Fibre Co. mills in the morning and later attended the afternoon technical meeting and the dinner meeting at the Monticello Hotel in Longview.

R. C. McCall, Chairman of the Department of Speech, University of Oregon, spoke at the dinner meeting on the various aspects of speech technique and the correction of speech defects. His highly entertaining talk was enthusiastically received by his audience.

Kenneth L. Hackett, Longview Fibre Co., Longview, Wash., was in charge of arrangements for the meeting.

A résumé of the Shibley papers follows.

1. "Photographic Standards for Dirt Control," by William F. Cyrus, Crown Zellerbach Corp., West Linn, Ore.

The determination of the amount of dirt in pulp and paper by the methods currently used is at best, time consuming and subject to much human error.

The method described here was devised to give a fast, reliable method for mill control work.

From the standpoint of customer acceptability, it will probably be agreed that the amount of dirt in paper is relatively unimportant in itself, but that the effect of the amount of dirt, which is whether the paper looks dirty or not, is important.

Dirt count methods which just count the total number of specks without considering the size and color of the specks, nor the color of the background, do not tell us completely whether the paper actually looks dirty or not.

The TAPPI method approaches this by considering the "visual impression" of a dirt spot. However, an observer must estimate the effective black area of each dirt spot, and this involves considerable time and human judgment.

In order to reduce the time and human error involved in making estimates of the effect of each single dirt spot upon the appearance of a sample, a method was devised which requires but a single estimate of the effect of all the dirt spots. By this method, the size, color, and number of dirt specks, and the color of the background are automatically considered.

The "dirt standards method," as we shall refer to it, consists of comparing the sample in question with a set of graduated standards. The dirt standards are numbered according to how dirty they look, and in operation, the number of the standard which most nearly gives the same impression of dirt as the sample is recorded as the "Dirt Number." The comparison is made rapidly, for prolonged study merely serves to confuse the observer.

The standards were made by photographing simulated dirt sheets on which dirt and shives were drawn in pen and ink. The prints were enlarged to $4^1/_2$ by $4^1/_2$ inches, the size of the original dirt sheets.

The standards were arranged in a series and numbered from one to nine, number one being free from dirt and number nine being what would ordinarily be judged as very dirty.

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The testing procedure for paper differs from that for pulp. Only the surface dirt contributes to the appearance of paper, so a dry sample and reflected light are used. The standards are compared with a $4^1/_2$-inch square marked on the paper.

With pulp, all dirt embedded in the sheet may contribute to the surface dirt of the finished paper, and by using a wet sheet and transmitted light, all dirt may be seen. The comparison can be made on handsheets by placing the wet handsheet over a $4^1/_2$ by $4^1/_2$-inch template painted on the frosted glass of a light box. The standards are placed alongside, and both are viewed with transmitted light.

Except for basis weight, the variables affecting most other dirt count methods, have little or no effect upon this method. The basis weight is only important with pulp, because all embedded dirt is counted. With too light a sheet, the sample is not representative, but as the basis weight increases, the dirt becomes obscured because too little light is transmitted. The optimum basis weight has been found to be about 37 pounds, but a weight of 39 pounds was used in this study for convenience in comparing with our older dirt methods.

Although these standards are not of actual pulps, the results are reproducible, and what may be equally important, the fact that the standards can be made from the negatives so easily should enable several mills to use the same standards and get comparable results.

In testing out this method, three observers, working independently, picked the same number dirt standard for over 180 out of 200 dirt sheets, on two different occasions. This means that the reliability of the method is better than 90%. In those cases where the same standard was not picked, the next standard whether above or below was selected.

The dirt standards method has been put on a trial basis at West Linn, and run in addition to the regular West Linn dirt count, which is a modified TAPPI procedure. A comparison between the two methods for a ten-week period showed good correlation of results.

Although the dirt standards method may not be the final answer to dirt control problems, we hope that this fast, reliable, and reproducible method may contribute to better testing.

2. "The Sources of Wood Dirt in Unbleached Pulp," by Carter A. Watson, Puget Sound Pulp & Timber Co., Bellingham, Wash.

Since cleanliness is one of the most important factors in the quality of unbleached sulphite pulp, the manufacturer is constantly faced with the problem of maintaining the dirt content of his pulp at an acceptable level. As is well known, most of the dirt in unbleached pulp originates from the bark, knots, stain, and rot in the wood, and because wood is a natural material of varying quality, the type and amount of dirt introduced into the pulp continually vary. Eliminating the dirt in the most economical manner to attain the production of uniform quality pulp is a problem of major importance to the industry. The methods normally used to accomplish this dirt reduction are: (1) wood selection, i.e., sorting and selecting the wood entering the sawmill; (2) wood cleaning in the sawmill, i.e., culling out the rot and other types of wood dirt; (3) dirt removal equipment in the pulp process line, such as rifflers, fine screens, and centrifugal classifiers. When considering a means of cleaning, usually more than one of these different methods will serve satisfactorily. However, all of these systems are costly, and to arrive at the economic advantage of one over another factual knowledge about the type and amount of dirt to be removed is often required.

A method is presented for determining the proportion of the dirt in unbleached pulp which arises from each source of dirt in a given wood supply. The method consists of sampling chips from the wood in question, sorting these chips into fractions according to the type of dirt they contain, pulping and processing these fractions individually, and finally determining the dirt contained in the pulp from each fraction. Thus it is possible to show how much of the dirt in the final sheet of unbleached pulp comes from each source, and to estimate the total dirt content of pulp produced from the supply of wood. The method was used to analyze several typical wood supplies and the results are presented. This information can be used to predict: (1) the dirt content of pulp produced from a combination of wood supplies, and (2) the dirt reduction obtainable if special attention were directed toward removing any particular type of wood dirt by extra cleaning in the sawmill. These predictions can assist in estimating the cost of obtaining pulp of a specified cleanliness by varying the wood supply and/or cleaning the wood. This cost may be compared with the expense of additional dirt-removing equipment which might be installed, such as centrifugal classifiers, additional screens, etc.

In practice close agreement was noted between results obtained by changes in plant operation and those predicted by the laboratory data.

3. "Special Problems in the Operation of an MgO Base Sulphite Plant," by John L. McClintock, Jr., Pulp Division, Weyerhaeuser Timber Co., Longview, Wash.

This paper covers five special problems encountered during initial and subsequent operation of the MgO base sulphite acid plant at the Weyerhaeuser Timber Co. Pulp Mill in Longview, Wash. The discussion of the problems is introduced by a general description of the existing acid plant from an enclosed flow diagram. Actually the process is quite similar to a milk-of-lime system. The specific problems encountered and the solutions developed are the following.

A. *MgO Handling.* The difficulties encountered in handling the dry MgO powder were caused by the low densities involved. The light powder acted like a fluid in mechanical handling equipment and the dust problem was appreciable. The most versatile method for handling the magnesia was as a water slurry.

B. *Magnesium Monosulphite Formation.* Magnesium monosulphite is only slightly soluble in the comparatively weak bisulphite acid formed in the adsorption towers. However, some monosulphite must be present to maintain the proper acid pH for maximum calcium removal on the acid filters and minimum sulphur losses in the exit gases. Closer control became necessary to keep the above conditions within the resulting narrow operating range. Frequent iodate acid tests, the use of an acid pH recorder, and observations of the acid color were used to obtain the necessary close control of the process.

C. *Sulphur Loss Out the Induced Draft Fan Stacks.* Sulphur is carried in the flue gases leaving the induced draft fan stacks as SO_2 gas and sulphuric acid mist. These losses must be kept to a minimum to prevent air pollution and to maintain high sulphur recovery efficiencies. The loss of sulphur as SO_2 gas is dependent upon the acid composition and concentration in the final set of absorption towers. Closer control was obtained with the use of a pH recorder to continuously indicate the acid composition in these towers. The loss of sulphur as a sulphuric acid mist is probably dependent on the amount of excess air used in the recovery furnaces.

D. *Magnesium Sulphate Formation.* Magnesium sulphate is quite soluble; however, the compound is not active in the cooking of wood chips to produce pulp. Therefore, any magnesium sulphate in the finished acid is a dead load that increases magnesia and sulphur losses throughout the recovery cycle. The concentration of magnesium sulphate in the finished acid was materially reduced by decreasing the quantity of excess air used in the recovery furnaces.

E. *MgO Reactivity Test.* Existing magnesia reactivity tests as used by the alkali industry yielded results that were difficult to correlate with magnesium bisulphite formation. Therefore, a series of tests was developed based on the actual formation of magnesium bisulphite from magnesia samples. The results obtained from these tests represent the ability of

the magnesia samples to form reactive or recoverable compounds in the acid produced in the acid plant.

4. "Seam Adhesives for Multiwall Bags," by Kenneth M. Shold, Crown Zellerbach Corp., Port Townsend, Wash.

The successful manufacture of multiwall bags is dependent to a large extent on the use of proper seam adhesives. These seam adhesives fall into three main classifications:

1. Standard seam adhesives.
2. Water resistant seam adhesives.
3. Waterproof seam adhesives.

Finding the best adhesive for each classification involves consideration of three types of factors: (1) physical, (2) chemical, and (3) psychological.

The choice of a particular adhesive for each classification is often limited by the type of paper involved and by the effect of heat on the adhesive bond.

R. M. TRUE, *Secretary*

Lake States

The January meeting of the Lake States Section was held at the American Legion Clubhouse in Appleton, Wis., on Tuesday evening, Jan. 9, 1951.

Martin Downs, A. P. Adrian, H. C. Crandall, D. S. Helmick, T. C. Catlin, H. P. Dixon, and H. W. Rowe

The speaker of the evening was Dan S. Helmick, Consulting Engineer of the firm Helmick, Edeskuty and Lutz of Minneapolis, who discussed "Power and Steam Generation."

H. C. Crandall, Chairman of the Section, introduced the speaker and pointed out that this topic was in line with the policy of the Section to cover as broad a field as possible in topics of interest to the membership of the group. He stated that while the number of people in the Section who are actually responsible for power in their respective organizations is small, still indirectly a larger number have a definite interest in the effect of efficient power production on over-all plant economies.

Mr. Helmick is a graduate of the College of Engineering, University of Minnesota, 1915. His affiliations are as follows: Junior Engineer, U. S. Dept. of Agriculture, 1915–1917; Captain, First Engineers AEF, 1917–1919; Assistant Engineer, St. Anthony Falls Water Power Co., Minneapolis, 1919–1922; Consulting Engineer with the firm of Helmick and Lutz, Minneapolis, Minn. working on various hydro and steam power plants in the Middle West for paper mills, packing plants, private and municipal utilities, 1922 to date.

Power and Steam Generation

Dan S. Helmick

THE problem of power and steam generation in any industry that uses large quantities of steam for process is fundamentally simple as regards general principles but can become quite involved and intricate when the application of these principles has to be applied to a particular case.

In other words, steam can be produced at any pressure and temperature with a wide variety of fuels, in boilers of various design with several types of firing equipment with a high degree of certainty of the efficiency and serviceability that will be obtained. The problem of establishing the characteristics of a steam generating unit to obtain the maximum economic and operating results is something else.

Also, turbo-generators can be secured that will obtain known results for the various steam conditions under which they might have to operate. The matter of establishing the operating conditions for them is therefore the fundamental problem.

The primary premise to be established before any attempt is made to arrive at the required steam characteristics and generator sizes is an exact determination of the actual plant requirements of steam, power, and water. This may seem like a foolish statement to make but too many plants have been designed on inaccurate premises or assumptions with the sad result that the new plant could not do what was expected of it.

It is amazing how few plants have even fundamental utility information in an accurate form. In general, accurate data on the following are required.

1. Kilowatt-hour consumption and maximum electric demand for 24 hours a day, 365 days a year.
2. Steam required, for plant purposes only, at the various necessary pressures and temperatures for 24 hours a day, 365 days a year.
3. The amount and quality of water required for plant purposes throughout the day and year.
4. Production records of quantity and quality of the plant's output throughout the day and year.

After these data are accumulated someone, and this should be the individual or individuals responsible for future output and production, must establish the changes contemplated in production in order to incorporate the adjustment in utility requirements that may be necessary. Sometimes this is a simple matter but often it is a serious problem since management at times cannot provide the information on a definite basis. In many cases management has come up through the

DAN S. HELMICK, Consulting Engineer, Helmick and Lutz, Minneapolis, Minn.

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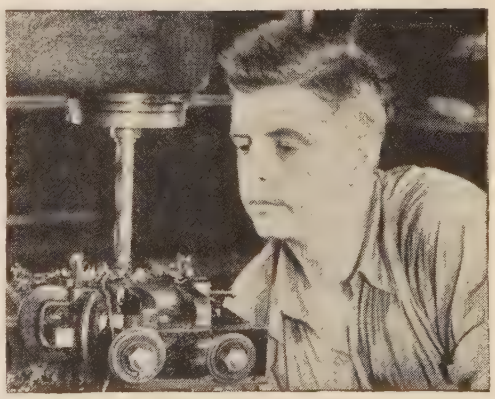

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production side of the business and thinks that steam, power, and water are more or less always available in the quantity and quality required. This assumption is seldom true but there have been several cases where the increase or change in production is well under way before someone awakens to the fact that the required utilities are not available.

Most paper mills own or are tied in with hydroelectric power. Unfortunately the availability of hydro power varies widely from year to year and from month to month. In considering the power requirements of a plant, extreme caution should be used in assigning the amount of prime or base power available from hydro plants.

Another intangible has been introduced in the problem of steam and power production by the recent antipollution law of the State of Wisconsin. This matter of pollution control is an involved one. Suffice it to say at this time that any decontamination procedure will necessitate additional power and may require or produce additional steam, all dependent on the system that may be adopted.

Another item that must be considered in kraft mills is that of where liquor recovery boilers fit into the general picture. Some mills have installed recovery boilers of high efficiency and high pressure. Others unfortunately still have a multiplicity of relatively low efficiency, low-pressure boilers that sooner or later will have to be replaced.

After the basic facts are accumulated, changes in future production determined or guessed at, a realistic view made on hydro power if available, the changes that may be involved in antipollution equipment considered, and the matter of liquor recovery boilers settled, the real job starts, that is to make "heat balances" for the various combinations of power and steam demands that may have to be met.

A "heat balance" in simple words is the determination of the maximum boiler pressure and temperature required to make the economical maximum of power from turbo-generators of the proper design and characteristics as a by-product of the plant's demands for process steam.

Theoretically, it is generally possible to establish an initial steam pressure and temperature that will produce the required power at all times from the plant's demand for steam. Practically, this is a dangerous and uneconomic thing to do because a ratio of steam to power may exist at the time the heat balance is made to establish the initial steam conditions but this ratio may be wrong by the time that new boilers are actually installed. Further, the cost of installation of equipment above certain pressures and temperatures may increase the cost to such an extent that the fixed charges on the additional cost exceed the possible reduction in operating costs.

In effect a steam turbine acts as a reducing valve and desuperheater between one pressure and some lower one and in the process produces power. The economy of this type of power production is what has brought about the adoption of the present use of high pressure and temperature steam production.

For example, and the following figures are approximate only, if a 2000-kw. turbine takes steam at 600 pounds, 700° F. at the throttle and exhausts to a condenser at 2 inches Hg absolute, the B.t.u. used or "heat rate" per kilowatt generated at full load is 14,200 B.t.u. per kilowatt-hour or 15,000 at 1500 kw. On the other hand, this same turbine with the same initial steam pressure but exhausting at 125 pounds would consume about 3600 B.t.u. per kilowatt-hour at full load or 3700 B.t.u. per kilowatt-hour at 1500 kw.

While these figures vary somewhat with different exhaust or extraction pressures, so long as the steam from the turbine does not contain moisture and within the size limitations generally used in industry, it is in general true that a kilowatt made on a by-product basis consumes only about 25% of the B.t.u. that a kilowatt made on a condensing basis does, and therefore, the fuel cost is in the same porportion.

As another example, if a 5000-kw. turbo-generator, steam at the throttle at 400 pounds, 750 degrees, operates at full load and $1^1/_2$ inches Hg condensing, 71.4% of the total heat input is lost in the condenser, 1.4% lost in unit, and only 27.1% converted to power. If this same unit were operated under the same conditions except that 50% of the throttle flow was extracted at 5 pounds, 37.2% of the heat input would be in the steam extracted to process, 37.0% wasted to the condenser, 1.3% lost in the unit, and 24.5% converted to power. Again, if this same unit were operated at 5 pounds exhaust (no condensing) 80.9% of the heat input would be in the steam exhausted to process, 1.0% lost in the unit, and 18.1% converted to power. The above data were taken from DeLaval Steam Turbine Co. Bulletin 4200-A.

The combinations of extraction and exhaust or condensing characteristics of the modern steam turbine are almost infinite in their extent. For anyone that may be interested in pursuing this subject further a book entitled "Modern Turbines," by Louis E. Newman of the General Electric Co., gives a portrayal of turbine possibilities in fairly simple language and without too much in the way of complicated mathematics.

Normal steam pressures in use in the paper industry vary from 5 to 175 pounds. Generally, superheat is a liability and in some cases cannot be tolerated. The pressure or pressures required in most mills are generally fairly well established. Whether a constant temperature is necessary must also be considered because while turbine governors or control will maintain a predetermined pressure of extracted or exhaust steam, the temperature of the steam will vary with changes in electrical load resulting from the shift in the amount or proportion of extracted or exhaust steam. It will thus be seen that in order to obtain steam without moisture at the lowest extraction or exhaust pressure at full load, study must be given to the thermal efficiency of the unit under consideration as well as the initial steam pressure and temperature.

After the heat balance figures are established and the economical initial steam pressure, temperature, and quantity determined, the matter of how to generate the steam must be worked out. There are a wide variety of reliable boiler designs available, the costs of which vary with the design. Probably the first thing to be established is the type of fuel available and therefore the equipment required to burn it. Some plants have coal, gas, and oil available at various times of the year, some have coal only. In this connection, with the cost of any fuel as high as it is today, and with the load factor in most mills as high as it is, no boiler unit should be considered that doesn't obtain 80% or better efficiency.

Some of the boiler plants installed in the last few years are obtaining in excess of 85% average operating efficiency without expending any appreciable amounts for the various super refinements that are available.

If all three fuels have to burned and quick changeover from one fuel to another is required together with maximum efficiency, a boiler with pulverizers, combination burners, and air heater will probably give the best results although the installation cost per thousand pounds of steam will be higher than with other types of equipment.

In general, today in most of the northern part of Minnesota, Wisconsin, and northern Michigan coal is the most economical type of fuel, but what John L. Lewis will do tomorrow is anyone's guess. Depending on the individual mill location, coal is generally eastern coal from the docks or rail coal from the midwest fields in Illinois, Indiana, or western Kentucky. The matter of burning the good grades of eastern coal is relatively simple, with pulverizers, underfeed or spreader stokers able to do an efficient job without too much maintenance expense.

However, to burn some of the midwest coals, if you can call it coal, is not so simple. Pulverizers of the ball or roller type give more consistent fineness, which means more consistent efficiency, with less maintenance. Underfeed stokers, even with clinker grinders and water-cooled tuyères haven't proved

very satisfactory. In recent years a number of spreader stoker installations, with stationary or moving grates, have been installed with satisfactory results.

With all of these types, consideration must be given to proper furnace design and water walls, and in particular the liberation per cubic foot of furnace shouldn't be too high or there will be trouble when a particularly poor grade of coal has to be burned.

To obtain the high efficiencies that are necessary today, heat recovery equipment is necessary. Air heaters seem to work in better with pulverizers, and economizers better with stokers. Care must be taken in sizing this equipment so that on holidays and week ends, the final exit gas temperature does not reach the dew point. If it does severe corrosion and fouling may occur.

Pulverizers and spreader stoker installations possess fly ash problems. In any installation, other than out in the wide open spaces, it is general practice to install fly ash eliminators to avoid nuisance lawsuits and conform with smoke ordinances.

With spreader stokers, particular study must be given to obtain the furnace turbulence necessary for complete combustion with high CO_2, the details of cinder returns, and the matter of external erosion of boiler and economizer tubes from fly ash.

A modern boiler unit with air heaters and/or economizers and fly ash eliminator has such a high draft loss that an induced draft fan becomes necessary. While it costs more it is generally good policy to put dual drive on induced and forced draft fans. This is particularly desirable if the boiler is a base load unit and the failure of one drive would shut down not only the boiler but possibly also a turbo-generator or the mill. In addition the ability to shift from motor to turbine drive or vice versa is at times very advantageous in adjusting the plant heat balance.

It may appear to be a foolish statement to make but many power plants are not what they should or could be due to insufficient study and improper arrangement of the necessary auxiliaries and the way they are piped up. Too often these items are bought on a price basis when they should be bought on the basis of obtaining equipment with maximum reliability and minimum maintenance.

Proper boiler feed pumps are of primary importance. Present practice is to use centrifugal pumps but care must be taken in deciding on the metal in the pumps so that it will stand up with the pH that exists in the feedwater. There should be sufficient pumps to handle the maximum boiler load with one spare. If possible, it is advisable to have at least one motor and one turbine-driven pump.

A proper discussion of feedwater treatment could be the subject of an article of indefinite length. Feedwater treatment and deaeration are prime requisites for satisfactory boiler operation and minimum maintenance. Most emphatically feed treatment becomes of paramount importance when higher boiler pressures are used.

Treatment should be considered on the basis of the amount of make-up required and the chemical analysis, including color and tannin. Any water can be treated so that it is suitable but the equipment to do it should be decided on only after consultation with some reputable firm of water treatment chemists, preferably one that does not also sell chemicals or equipment.

A deaerating heater that will remove the oxygen down to at least 0.03 cc. per liter combined with a storage section to give adequate reserve feedwater supply is a basic essential. It should heat the feedwater to at least 212°F. but higher temperatures are advantageous, particularly if the boiler has an economizer.

A complete system of steam and feedwater metering and combustion control is another essential. There are several good makes available and only the best should be purchased because with the present cost of fuel the best is none too good. A metering system is also required if cost and distribution figures are to be obtained that are anything but a guess.

Coal and ash handling are a pain in the neck in anybody's language. One of the principal problems that occurs is how to unload car coal that has frozen solid in transit. There are several makes of vibrators on the market but none of them seems to give 100% results. The matter of handling coal from the track hopper to the bunker can be handled in several ways depending on conditions. In recent years it has become pretty standard practice to make the bunker dust tight and to use a dust-tight system, including coal scales, from the bunker to the boilers. Another item that should receive attention in order to get proper feeding and/or distribution in the coal burning equipment is the fact that all coal should be sized down to a minimum size, say $^3/_4$ inch. Ring type crushers do a good job on this with minimum maintenance on even the poor grades of midwestern coal. Another matter that should not be forgotten, particularly with spreader stokers, is that coal should be gotten to the stoker with a minimum segregation of large and fine particles.

Ashes can be handled wet or dry depending on how they are to be disposed of. If the boiler room is to be kept clean, as it can be, a totally enclosed and dust-tight system of handling and storage should be considered.

Unfortunately, when new boilers or equipment are to be installed these quite often must be placed in present buildings which makes it difficult at times to get anything but a "shoehorn" job. If possible, new equipment of this nature should be placed in new buildings that make it possible to get proper elbow room, which in turn insures better and cheaper maintenance with less grousing from the maintenance men.

The question of the type of exterior may have many answers which from a practical angle vary with the climate. There are available many types of concrete, steel, and asbestos panels, with and without insulation but, everything considered, for permanence and minimum maintenance in this northern climate it is pretty hard to beat standard brick and tile construction.

The exterior architecture of the building varies with the individual case, the public utilities generally being the most willing to spend money for architectural effects. That looks do not pay dividends is a pretty good rule to remember. With the cost of maintenance labor at what it is today it is often better judgment to use second-quality salt glazed tile on the inside and common brick on the outside than to use face brick on the outside and common brick on the inside.

The electric load in all mills has increased year after year. How many mills have revamped their distribution system, substations, load centers, and switchgear to safely handle present loads? From observations in many places, if there is anything to the figures given by the switchgear specialists on interrupting capacity of breakers, one wonders why there haven't been more fires and service interruptions.

In considering a new power plant it is also a good idea to check the present electric distribution system and substations and five to one they will be found inadequate.

In considering new generator voltages, 2400 is the minimum. In many cases 4160, 6600, or 13,200 volts has been adopted with distribution at generator voltage to strategically placed load centers in the mill. With a plot plan of the mill it is possible to locate the various points of electric demand and then determine the location for new load centers of an economical size. This may require new secondary wiring to many motors but a large portion of the secondary wiring in many mills should have new wiring to insure more reliable service.

Modern design in switchgear is metal clad with air circuit breakers being used instead of oil circuit breakers. Control panels can be built separate and away from the gear proper which sometimes helps if space and floor limitations prove to be a problem.

Too often the engineer responsible for the design and construction of a power plant gets so wound up in the detail en-

gineering aspects of the job that he forgets the one primary consideration that should be kept in mind, specifically, who are the men who are going to run and maintain the equipment? In many industrial plants management thinks of the power plant as a necessary evil and are at times reluctant to pay for an adequate number and caliber of men to properly operate and maintain the plant. With this in mind, equipment should not be too intricate or involved and beyond the capabilities of the men to run and maintain it.

If the boiler room is to be kept shipshape, some attempt must be made to get away from the dark holes of the past and provide light, air, proper wash and locker rooms, etc., so that the operators will develop a sense of pride in the appearance of the plant and themselves.

Maintenance problems and time are materially reduced if proper advance thought is given to such small items as a manhole in each end of a boiler drum, adequate platforms and walkways, and enough room to do the job without standing on your head or hanging by your heels.

Thirty years ago boiler room operators had to have more brawn than brain, they worked 12 hours a day, handled coal in and ashes out by hand with the result that they developed callouses on their hands. Today, things are better for the men and properly so. The eight-hour day, mechanical means for handling coal and ashes, automatic combustion and feedwater control have changed things so that the average present-day operator is more liable to have callouses on his rear end than on his hands. In fact in some plants they have so little to do that they won't even see to it that bearings are getting the proper amount of cooling water, that firing equipment is adjusted with a change in coal size or grade, etc. Also things go wrong so seldom with present-day equipment and controls that are properly maintained that when they do the operator tends to lose his head for lack of knowledge of how to remedy the situation.

All of this leads to the fact that no piece of equipment is any better than the man who operates it. Too much care cannot be given to the selection of a chief engineer who not only knows the answers himself but has the patience and ability to select and properly train his subordinates.

All of the above attempts to touch the high spots of an intelligent study of the facts and equipment pertinent to a modern steam and power generating plant. After they are assembled, the facts should be available which enable one to come to a conclusion as to whether it is advisable to self generate all power and steam, produce a portion of the power requirements, and purchase the remainder or purchase all power requirements.

The proper answer cannot be determined without a knowledge of what stand the local utility will take. Years ago the utility engineers tried to prove that the production of power by an industry on a by-product basis was not a practical or economical thing to do. Very few of them take this position any more—there are too many industries that have done it with success. If both the industry and utility are broad-minded enough to consider each case on a basis of fundamental facts and economics the answer in most cases is for the industry to install the necessary plant to make all the power it can as a by-product of its own steam demands and for the utility to supply a certain basic minimum demand and kilowatts that the industry would have to make on a condensing basis. This requires parallel operation between the two industries which is a thing some utilities object to. This relationship is generally easier to accomplish where the utility is not too large and the local manager is not too far removed from the top brass that make the ultimate decision.

In conclusion, there are certain basic facts to be constantly remembered when any industry that uses process steam contemplates investing money in new steam and power generating equipment, with or without any connection with the local public utility company.

1. Plants on their own are less liable to shut down, particularly in the summer, than those connected to a utility transmission line. Shutdowns in such industries as paper are expensive.

2. A modern industrial boiler plant with a high load factor will produce steam as cheaply as a utility plant with the possible exception of the large, high-pressure, high-temperature, central stations that operate on base load.

Robert F. Reed, Freeling M. Truesdale, and H. C. Crandall

3. If the industry fuel or recovery boilers are old and/or inefficient, and with the present cost of fuel, it will sooner or later be necessary to replace them. When this becomes advisable the difference in cost between a 250-pound unit and a high-pressure one will not be as much as might at first be expected.

4. A kilowatt made as a by-product of process steam demands will have a purchased fuel cost of only about 25% of one made on a condensing basis, whether by the industry itself or others.

5. For every kilowatt used someone must spend a certain amount of money for equipment on which fixed charges and a profit must be earned. If an industry is faced with the necessity of installing new boilers to take care of its own steam demands the additional or incremental cost of high-pressure boilers plus electric generating equipment is usually much less than when the total cost must be charged against each kilowatt.

April 10 Meeting

An afternoon and evening meeting was held at Wausau, Wis., on April 10, 1951, to discuss "Printing" and commemorate the Twentieth Anniversary of the founding of the Lake States Section of TAPPI.

The schedule of the meeting included a visit to the new carton plant of the Marathon Corp. at 1:30 p.m. O. O. Eggebrecht, Superintendent, had a number of guides who took the visitors through in small groups.

At 3:15 p.m. a "Symposium on Printing" was held at the Wausau Club with Freeling Truesdale of Nekoosa-Edwards Paper Co. speaking on "Printing Paper End Use Specifications" and Robert F. Reed, Research Consultant of the Lithographic Technical Foundation, speaking on "Paper for Offset Lithography."

A social hour was held from 5:30 to 6:30 after which dinner was served. The evening speakers were Rev. G. K. Hill, First Chairman of the Section, who spoke on "The Early Days of Lake States TAPPI," and Allen Abrams, Vice-President of the Marathon Corp. and a former President of National TAPPI, who spoke on "The Years Ahead."

The program and meeting were very successful and were attended by approximately 160 members.

The Years Ahead

Allen Abrams

The old time prophet has been replaced pretty much by the modern pollster. This fellow can tell you with accuracy just what is going to happen—except of course when Truman runs for President! Maybe the best way is to predict only what will take place when you are gone; then your mistakes will be buried after you.

Before we try to look ahead it would be a good idea to see where we have been. So turn back to the very beginning, that utterly incomprehensible period when there was nothing—only a void. Yet somehow out of that nothingness an Infinite Power created energy and the atom. It was a miracle the like of which has never happened since.

Allen Abrams

Geologists estimate that our earth was born two billion years ago. But since neither you nor I can comprehend that, let us compress these two billion years into what we will call one earth year. Then, as in reading a book, skip a lot of the first portions until we come to early December of our earth year. At that time there appeared on our planet a creature which persisted until the last day of December and yet which disappeared before man ever saw it. The dinosaur was fantastic because it came in so many sizes and shapes; the largest being which ever roamed the globe, it was up to 80 feet long and weighed as much as a loaded boxcar. The dinosaur was amazing for it had a brain only the size of a kitten's, encased in 10 inches of solid bone, yet, by some circumstance the animal endured for 140,000,000 years.

Come now to civilized man who appeared on the earth just 3 minutes ago; then go further, for you and I are concerned almost entirely with the last 5 seconds of this earth year. We single out that period because these 5 seconds have yielded the principal discoveries and inventions of all time. In this era came pioneers who were interested in the world about them—scientific men who assembled and related this information. There was Newton and the law of gravity showing how the world is held together; Galileo and his telescope to study celestial bodies; Hertz and the electromagnetic waves penetrating space; Dalton and the atomic theory; Mendeleev and his periodic table of the elements; Einstein and his theory of relating energy and mass. These and countless other scientists were the early explorers into the unknown.

Move on in these last 5 seconds of our earth year and note the developments coming out of these early theories and discoveries—more than 500 important inventions, and incidentally not a single one from Russia! Here was Whitney and the cotton gin to produce more cloth; Howe and the sewing machine to make more garments; McCormick and the reaper to increase our food supply; Fulton's steamboat, Westinghouse's airbrake and the Wright Brothers' airplane to speed our transport; Morse and Bell and De Forest to make communication easy.

Study that long list and note how many of these inventions have come in this very last $^1/_2$ second of our earth year—that infinitesimal period of history since 1900, in which all of us have lived. See how completely these developments have altered life here and throughout the world, transforming it from an easygoing, comfortable, independent existence to the rushing, nervous, interdependent life of today. In our time we have seen a revolution of things, to produce our boasted high standard of living—more automobiles, refrigerators, washing machines, radios, electric blankets, antibiotics, cigarettes, and gadgets than could never have been imagined.

Who started all of this? Was it the teacher—the preacher—the sociologist—the farmer—the laborer—the merchant—the banker—the businessman? No—they helped it along but, as the lawyers say, they were only accessories during and after the fact. Who then was responsible? It was that curious

Head table, l. to r.: G. K. Dickerman, S. D. Wells, F. M. Truesdale, Allen Abrams, H. C. Crandall, Rev. G. K. Hill, R. F. Reed, and L. E. Simerl at the 20th Anniversary Meeting of the Lakes States Section

person who persisted in knowing how the world was made up so that he could take it apart and put it together better. It was you and I and every other fellow who looks down a microscope or peers into a test tube or counts electrons.

Yes, for better or worse, we scientists and near scientists are the people who started this revolution and who keep it going. We can point with pride to the great benefits coming from our efforts. We can shrug off lightly the evils and protest that it is the sociologist and the politician who are responsible that the automobile is used for highway robbery, the telephone to transmit gambling bets, the motion picture to demoralize our young, and atomic fission to blow people to bits. But isn't it reasonable that the very people who brought these things into being should assume some responsibility for their future conduct? Let the father beget a child and turn him loose into society without restraint and you have lawlessness. Let the scientist create, without regulation of his brain child, and you have anarchy.

Have you been shocked and angered by the revelations of the Kefauver investigations—the syndicates of vice with their big-time gamblers, pimps, thieves, trigger men, and peddlers of dope? Do you view with alarm the gambler bribing fine young college athletes to turn traitor to their own schools?

Follow the Fulbright examination of just one Government bureau with its trail of bribery, corruption, and sale of official favors for money. Here is intrigue that leads even to the White House, yet the President proclaims that all these are honorable men. If all this doesn't make your blood boil then you need an injection of red corpuscles!

Have we been disturbed over the creeping socialism which has infiltrated our country, plunged us into debt, and placed power in the hands of men who are wrecking our country? Are we frightened at communism and its penetration into high Government offices and departments? Are we alarmed over the fact that Hiss and Coplon and Rosenberg and a host of other traitors have plundered our innermost secrets and peddled them to our enemies? And does it ever come to our minds that the decline and fall of great civilizations have come from within and not through an outside enemy; that our own beloved country can go the same way?

Well, if we are really alarmed what are we going to do about it? I propose that we begin seriously and conscientiously to act as citizens. If our country is to survive it can be saved only by you and me. *If our country is to survive it can be saved only by you and me.* Who better is fitted by aptitude and ability than the man trained to analyze problems and to work out their solution? Yes I know that each of us wants to work vocally from the easy chair on the national and the international problems. But the real solution of the troubles of the world lies right here in our own community. The Main Street of America is the most important thoroughfare in the world. Let men of intelligence and ability like you take their places on Main Street—as aldermen, on the Community Chest, as members of the School Board and in the councils of the church.

You will find work to do, plenty of it and now. It should disturb you to learn that only half as may people in proportion vote in our country as in Italy or France. You will be ashamed to find that just one out of every five voters took the trouble to visit the polling places two weeks ago. And yet our G.I. boys are suffering and giving their lives to preserve our sacred right to cast this little piece of paper—the most important in the world.

Listen to the words of a boy who can say it much better than I can. He was a paraplegic who died recently after 4 years of suffering in a Veterans' Hospital. "I have come back from death to a world that I no longer care for. I, who have engaged in the great struggle to save the world from tyranny, and having seen my comrades die for this cause, can now find no peace in the world or in my own country. . . . All the troubles of the world originate in the common man. The selfish and greedy ways of nations are merely the ways of each individual man multiplied a hundredfold. When the morals of the common man drop, so do the morals of the nation and of the world. . . . If man wishes peace again, he must return to the great Commandment, 'Love thy neighbor as thyself.' "

Sometimes I wonder whether this thing we call democracy is right, whether you and I are just too dumb to understand. If this kind of government is as good as we claim, then we ought to be the greatest salesmen in the world, for we have the finest product to sell. We ought to get out and tell the people in schools and offices and stores and factories that no other system offers the same opportunities and that no other plan ever devised protects so well the freedom and dignity of man. We can stop every "ism" in the world cold if we have a mind to do it.

Sit down tomorrow and write to your President, Senators, Representatives, to the Chairmen of these Investigating Committees; tell them just what you think about the state of affairs. Support them when they are right; criticize when they are wrong. Write again and again for these personal letters from the home folk determine their actions.

Of one thing we may be certain—that this country of ours must have a rebirth and a resurgence of spirit if we are to survive. Man with his fertile brain has unlocked the last great secret of the universe. Now in his own hands he holds the power over life and death. Which shall it be? Will we do better than the dinosaur? Have we a great enough stake in America that we too will pledge our lives, our honor and our fortunes to defend her? Shall we be creators of ideals as well as ideas? You and I will make that decision. Tell me what you will do and I will prophesy the years ahead.

Offset Lithography

Dr. Reed stressed the need for the paper manufacturer to know more about the problems of the lithographer and for the lithographer to know more about the problems of papermaking. He stated that the offset process was born in 1906, that in 1930 gross sales were $75,000,000, and in 1950 $600,000,000. Paper consumption has grown in proportion to this dollar volume.

The offset press was the basis for the mushroom growth of lithography since 1915. While a very smooth paper was required in letterpress work in order to obtain uniform printing, in offset lithography, by means of the rubber transfer blanket, quality halftone printing could be accomplished on rougher paper.

Five types of plates were discussed: (1) original, where a greasy image is drawn on the plate, (2) hand transfer, (3) photographic, (4) deep etch, and (5) bimetallic. These plates were described and advantages and disadvantages of each were indicated. It was explained that while up to 250,000 impressions could be obtained on a zinc plate, up to 1,000,000 impressions may be obtained on the bimetallic. This latter plate, being the most recently developed, was described with reference to the technical theory which is responsible for its adaptation to the lithographic process.

The advantages of offset lithography were indicated as: (1) less ink used, (2) less pressure, (3) less offset, (4) little make-ready time, (5) less plate cost, (6) more printing speed, and (7) versatility in that a less critical range of paper finishes may be employed.

Special inks must be used, and the vehicle in the emulsion must be stable since an oil-in-water emulsion would otherwise occur. Thereafter, Dr. Reed described types of inks employed covering also the new resin inks and heat-sealing inks.

Paper requirements were next explained. The speed of printing has much to do with these requirements, but generally the specifications should be analyzed from two points: (1) how they affect the operation of the press and (2) how they affect the quality of the printed sheet. In all cases the paper must be flat and to this end moisture content is very important.

Moreover hysteresis should be recognized in that it is easier to condition to a specified equilibrium moisture content from a high initial value than from a lower one. Moisture transfer to the sheet from the press was explained.

Lint is very troublesome in printing and can be checked by a subjective test if one knows how to look for it. Too much filler improperly anchored in uncoated sheets is not good since it transfers in the printing operation.

The influence of pH of the paper on the drying of inks was discussed. A high pH insures better drying, a low pH longer drying. In uncoated sheets a pH of 5 or higher is desirable. In a coated sheet the pH may be controlled by use of calcium carbonate.

Better testing procedures for ink receptivity of paper and "pick" of paper surface should be developed. At present the only way to determine ink receptivity of paper is to run it on the press. The wax pick test is found wanting because, among other things, the test area is very small. Development of a test to cover larger areas would be helpful.

Printing Paper End-Use Specifications

Freeling M. Truesdale

It would be difficult to find three industries more closely interrelated than printing, ink, and paper. It is rare to find a process where one is used and not the other two in some form.

Specifications for printing paper in general is too broad a subject to discuss because no one can rightfully say what is and what is not a printing paper. Twenty years ago there existed a rather sharp line of demarcation between such general grades of paper as Newsprint, Book, Writing, and Wrapping. About any paper to be printed was considered as a fine paper and any not to be printed was in the coarse paper group.

Technological advances in the fields of printing, packaging, and papermaking have changed this pattern of thinking so today let us confine our discussion to so-called fine papers such as bonds, ledgers, mimeograph, etc., mainly printed by Lithographic, Letterpress, or Rotogravure.

Considering only these three main printing processes one can select quite a range of paper for any one process and obtain a desired result provided art work, plates, ink, etc., have been properly prepared and balanced with the paper stock selected. Here is where it pays to follow an old slogan, "Consult your printer before approving a layout." Such planning, as a rule, results in money saved and a more satisfied end user.

The word quality *should* be defined and at first thought one will say, "I know the definition." Not quite so simple when you begin to think about the simple word used and heard daily. "Quality" has been defined many ways and Webster says it is an essential property, a distinguishing element or characteristic. Facetiously, someone said quality is any property that a customer wants or thinks he wants. True, many times, but such an evaluation of quality will be of little aid to successful printing or end use. Our problem is *what* and *how* to set specifications that will make these properties of quality valuable and indispensable.

Uniformity of any one quality is probably of more importance than the average level of that quality. For example, in finish or color, the important factor is to keep the quality level uniform. Often the customer is not concerned with an exact shade of color but does object, and rightfully so, if there is a noticeable color change in a run of letterheads or any other type of printing.

Qualities such as smoothness, bulk, gloss, mullen, tensile, etc., can be measured and expressed numerically to some degree and we would think that all that might be necessary would be for the printer to say "I want a paper with these qualities." From a paper manufacturer's standpoint this request might be impossible or would result in paper that would be far too costly to produce. In this connection it has been aptly stated, "Perfection is impossible to attain and costly to approach."

A student of fine papermaking said quality consists of attributes determined by use requirements such as printability, creasability, writability, etc. These use requirements are influenced or mentally measured by aesthetic values such as color, formation, cleanliness, appearance, etc. From a papermaking standpoint these aesthetic values are the results of experience and judgment but cannot be well expressed numerically. Then we have test values which may be specifications that play an important part in end-use requirements such as physical, optical, chemical, electrical, and dimensional. Such test values can be measured and expressed in terms of numerical values accepted and understood by both the paper manufacturer and end user.

So far we have agreed on what type of printing and paper we are to discuss. We have explored ways and means of expressing quality which should control the specifications. The problem confronting the printer is "How will the paper perform," and in too many cases, due to a lack of proper investigation on the part of the printing salesman or the paper salesman, the printer has only part of his answer even if the paper goes through the press satisfactorily because he has not been informed as to the end-use requirement. Press performance is only part of the story because it has been said aptly that a product is not sold until in the consumer's hands and used. Thus, to complete our triangle of consumer, printer, and paper manufacturer, sometimes referred to as the graphic arts triangle, we must first know the end-use requirements and only through accurate knowledge of such end-use data can we hope to write specifications that will result in the manufacturing of a paper properly suited for printing and the end-use requirement.

We know that too many times exacting records are kept and later statistically analyzed with no thought in mind of what the end-use requirements of the paper might be. How much more would be accomplished if the problem was approached from the end-use requirement and the technician's time was spent in running opacity rather than mullen if the success of the sheet depended on show-through.

Some time ago we investigated a complaint that involved a buff ledger paper and as the complaint was received at the mill it read poor color match between rolls. Reviewing the out-turn samples from the run indicated that the run was a good commercial match for our buff ledger color standard. We requested samples from each roll delivered and when compared to our standard we felt a commercial color match had been maintained.

We decided to visit the end-user's plant and try to find out why he felt we had made such an unsatisfactory delivery. After a few minutes in the customer's plant we had the answer. His end use was to glue the paper to wood veneer which varied in color from almost cream white in the sapwood to dark brown in the heartwood, and so the termed color variation turned out to be show-through. We set minimum opacity specification which had never been considered prior to this time and the problem was solved.

It seems to me that the important thing is to know what quality controls the end use, whether it be physical and measurable or an aesthetic value, dependent on someone's skill.

Uniform surface conditions are recognized as essential to the printer for proper make-ready and ink selection, by many consumers for proper end use and, if not necessary, desirable to the paper manufacturer. Even with such recognized major importances dependent on tests for smoothness and wax pick

Freeling M. Truesdale, Nekoosa-Edwards Paper Co., Port Edwards, Wis.

we recognize that such tests as run and expressed today are quite inadequate as both tests are relatively slow, thus few can be made on a run of paper, but of greater importance we can evaluate only $^1/_2$-inch-square pieces of paper whereas in many cases the printing press will apply a like test to every square inch of paper from a 50,000-pound delivery.

On the average job our present method of testing with all known limitations seems to be quite satisfactory. About the time we have become complacent and proud of our endeavors we find that a 10 wax test is unsatisfactory but a 12 will just get by. At such times we realize that new research development work which will measure surface tack on a full $8^1/_2 \times 11$ sheet is of utmost importance.

By the same line of reasoning we realize the possibilities of better controlled smoothness within a range of less than 50 seconds due to technological advance of weight control by use of *beta ray*. How could we expect to have uniform smoothness on wider paper machines running at speeds of 1500 to 2000 f.p.m. until we have some revolutionary changes in methods of testing and control.

I am confident that in certain end-use requirements it is recognized by the user that under present papermaking practices and with available equipment it is impractical to expect to obtain paper for example that will be uniform enough in thickness across 100-inch machine to produce satisfactory end-use results. One large publication printer recognized just this problem some time ago and at first considered the testing of every roll of paper. Naturally, such a testing program was not practical but by making a study of tests and working with one paper mill they came to the conclusion that in order to overcome this variable they would have all front rolls identified and likewise the center and back rolls. The rolls from front, center, and back were kept separated in their warehouse and so sent to the presses with the end result that they have materially improved their over-all printing quality and reduced costs.

There are cases where no specific specification or quality can be set to take care of the desired end result. By the end user and the papermaker working together and knowing one another's problems as well as physical limitations it is often possible to work out a satisfactory type of paper.

Let us review the case history of several thousand pounds of unusable *Ammonia Leak Test Paper* because the end user and the manufacturer were not together on end-use requirements.

The original order placed by the purchasing department of a nationally known refrigerator manufacturer was with the local paper agent, who in turn placed the order with a converter. All this sounds very complicated and a roundabout way to do business but such is not too uncommon where a converted item is required.

Our converter friend had bought paper from us for many years and also several grades but never this grade. The order as placed called for creped wet strength, bleached toweling. Nothing unusual about such a grade, however, this order specified no wet strength chemical to be used. As prime manufacturers we did not question the order because the converter often bought bleached creped toweling, some with and some without wet strength.

Actually this paper was cut in strips about $1^1/_2$ inches wide by 4 inches long banded into bundles containing approximately 100 sheets, then dipped in a 1% alcoholic solution of phenolpthalein, the excess solution pressed out in a 10-ton hydraulic press, dried at room temperature for 24 hours and then at 100°F. for 72 hours.

Quite a converting process and also remember the long chain of command in placing the order. When informed that the paper reacted rather slowly when exposed to ammonia fumes we were at a loss to appreciate the story.

Had we known the end-use requirement we would have used no alum in the formulation, neither would we have used a blue dye which resulted in a bleeding problem but would have supplied a neutral sheet for fast phenolpthalein reaction and a natural color for no bleeding.

Who should be charged with this error? We believe the refrigerator manufacturer should have had specifications for a technical paper. We also believe the paper agent and the converter should have asked a few end-use questions which, no doubt, would have prompted us to realize this was not just regular bleached toweling less wet strength.

This case history proves that all must work together and know the end use. In the case just discussed I think we will all agree that the conventional test applied to paper would have been of little value.

In closing we should touch on curl and dimensional stability of paper under varying relative humidity conditions. Papers such as glassine and parchment have the fibers very closely packed or to be exact, gelatinized, and when the paper is formed, become practically a solid mass without air spaces. When such papers pick up moisture, the expansion of the sheet is very great in comparison to a loosely formed paper such as tissue.

Some place in between we find mimeograph and bond. All of these papers can be printed by offset but more trouble can be expected on the glassine type than on a bond type of paper.

On a bond or mimeograph it is possible to somewhat overcome any surface softness disadvantage by surface sizing the sheet with starch or glue. Thus, it is possible to produce nearly an ideal offset paper with a loosely formed and maximum air space between the fibers in the center of the sheet but with the surface plated so to speak, to receive the ink. Such a paper should have less tendency to expand or contract under changing humidity conditions than a uniformly densely formed sheet.

Dimensional change plays an important part in register form printing where a controlled punch form job is being run. In such a case all copies must be in perfect register after printing and collating because they are guided through the tabulating machine by a series of pins.

This particular problem is of major importance today as many government forms are being run on such tabulating equipment. Often the forms are printed in a relative low average relative humidity area and then distributed to several centers with varying humidity conditions. The question has often been raised "has tabulating equipment advanced faster and to a finer degree of precision than can be expected of paper which is subject to reactions governed by basic laws of nature."

Dimensional stability of a sheet will, no doubt, continue to be one of the major topics of discussion and worry for both the printer and the paper manufacturer. A great deal of research has been expended to date in an effort to minimize this reaction because every one is agreed that the basic reaction is as fundamental as nature.

We would continue for hours looking over cases and reviewing case histories, where a paper with improper quality was selected.

So, in closing let me again emphasize—know the end-use requirements of the paper and then test for the quality and build for the quality that is essential to the end use. If such a sheet is printed other qualities will, in most cases, be satisfactory.

We as technical men have a real opportunity to be of service by helping our sales forces find the end-use requirement and then demonstrate to them how it is possible to build a sheet that will meet such a requirement. Let's make and sell paper on performance basis rather than fast talk about brightness or whiteness, which most paper users think are one and the same thing, and even after a comprehensive discussion of the subject would not be able to distinguish between a bright or a white sheet. Most people do know what they expect of the end use and it is up to us to satisfy such a requirement.

We have started a program at Nepco where a study is made

of papers that perform as well as those that do not perform. We are trying to anticipate end-use performance and eliminate specifications that are useless. We believe the program is paying dividends and will be better able to evaluate the same when the paper market again returns to normal conditions.

May 15 Meeting

The Lake States Section met at the Butte des Morts Golf Club, Appleton, Wis., on Tuesday, May 15. About 150 attended. Henry C. Crandall of the Mosinee Paper Mills, Mosinee, Wis., presided as Chairman.

R. G. Macdonald, Secretary-Treasurer of TAPPI, attended and briefly discussed some of the current activities and assisted in introducing the speaker of the evening Albert E. Bachmann, Vice-President of the Missisquoi Corp., and former President of TAPPI.

Herbert W. Rowe, Secretary of the Section, reported on the results of the mail ballot for the election of officers. The following officers were elected:

Chairman: Alan P. Adrian, Neenah Paper Co., Neenah, Wis.
Vice-Chairman: Herbert W. Rowe, Nekoosa-Edwards Paper Co., Port Edwards, Wis.
Secretary: Robert J. Seidl, Forest Products Laboratory, Madison, Wis.
Treasurer: L. A. Moss, Whiting-Plover Paper Co., Stevens Point, Wis.
Executive Committee:
J. Richter Salvesen, Marathon Corp., Rothschild, Wis.
Sidney D. Wells, Institute of Paper Chemistry, Appleton, Wis.
Clyde R. Faulkender, Hoberg Paper Mills, Green Bay, Wis.

Albert E. Bachmann gave an interesting talk on "Applications of Engineering Thinking." Mr. Bachmann said, in part:

"In the more practical phases of business affairs it is often necessary to deal with inexact sciences, to which the more rigorous scientific type of thinking is not wholly applicable because of inherent limitations of consequences, time, and dealing with less precise materials. This calls for consideration of the effectiveness of using for action various additional thinking instruments, aside from rigorous logic and induction, such as intuition, semantics, the continuum, voluntarist logic, analogy, and more extensive use of classification. To these, inclusive of scientific induction, might be collectively assigned the term Engineering Thinking, as distinguished from the more rigorous Scientific Thinking alone. The application of all forms of knowledge resulting therefrom, including science and correlated composite experience in the form of Principles, Know-How, and Rule-of-Thumb procedures in the field of practical business affairs, might then be considered as a figurative definition for Engineering.

"For corroboration of the practical utility of engineering as so defined, it might be in order to review the contributions of the Chemical, Mechanical, and Electrical Engineers to the increased production and relatively reduced costs of the past 30 years. Theirs has been a most predominant part in this progress.

"Engineering fundamentally has developed from practical Rule-of-Thumb and Know-How upward instead of from Science downward by addition of increments of knowledge arising out of correlated composite experience and Science. It might be in order therefore to consider applying analogous methods to increase our knowledge in other practical fields where of necessity less precise materials must be dealt with. Such fields of activity might be and are being referred to as Human Engineering, Organization Engineering, Cost Engineering, Quality Engineering, and Personal Engineering. To this list might be added another of importance—Paper Engineering, involving the basic principles of Papermaking."

Human Engineering

"Human Engineering as a form of organized Knowledge contemplates essentially the development of principles that will work universally to bring about the willing cooperation and teamwork of all members of an organization. Any cost reduction resulting as a by-product of these principles will only be attained if the principles of Human Engineering are sincerely subscribed to.

Standing: H. C. Crandall, L. A. Moss, R. G. Macdonald, and H. W. Rowe
Seated: A. P. Adrian, A. E. Bachmann

"Essentially, Human Engineering consists of establishment of the highest ethical standards of conduct and working toward a bilateral approach to them through operation on the basis of intelligent cooperation factored down, through semantic analysis, to its specific referent of 'yielding' under the proper circumstances. As a prerequisite for gaining such a high plane of human relations it becomes first necessary to establish a Belief relationship built on a long term program of opening the closed mind and repeated actions arousing confidence.

"Human Engineering seeks the development of principles which will work practically to attain the over-all objective of Management running the business for the best long-range interests of the Customers, Employees, Stockholders, and the Public. Basic underlying principles deal further in detail with reorientation of Management philosophy and getting the work done as well as the principles of defensive circumvention against encroachment of purposely minimized legitimate unilateral management functions.

"Human Engineering is continually gaining recognition as a legitimate important phase of Management by which not only are the ethical standards of business raised but also as a by-product costs are lowered and the preservation of democratic government is insured."

Cost Engineering

"Cost Engineering finds its need in the fact that modern conditions of competition have effectively changed the Cost-Profit-Price equation from 'Cost plus Profit equals Selling Price' to 'Selling Price minus a reasonable Profit equals Cost Objective.' The cost objective lies ultimately in the continuous attainment of a multitude of standards, for machine and labor performance, yields, and materials and expenses. The development of such detailed standards for everything, the development of a system of control and their continuous improvement of standards in progressive steps to the ultimate, through tests, improved methods, and engineering and cost research, is the function of Cost Engineering.

"As a result of the engineering approach to costs over the past 20 years there is emerging a growing recognition of the limitations of actual costs. These limitations arise from the inclusion within actual costs of the effects of all the mistakes and inefficiencies in addition to the effects of economic condi-

H. M. Rice, H. J. Perry, G. W. Brooks, H. B. Spector, and H. A. Spencer

tions and Acts of God. These latter extraneous elements are suitably earmarked as variances in a standard cost system and become the targets for cost reduction efforts.

"For control essentially separate but coordinated systems must be developed for control of the Continuity of the Business at administrative levels, Profits at general management levels, Operation at superintendence levels, and Routine at foremen levels. Cost Engineering also involves the establishment of the control system, beginning at the bottom for translation of the standards into standard costs, departmental and over-all budgets to the point at which they are handled as an accounting function.

"Cost Engineering further embraces research among the methods of assembling and displaying the standards and the cost figures for most effective control as well as research into the development of standards to the ultimate."

Personal Engineering

"As a result of the faster pace in industrial life some thought must be given to the development of the individual to his fullest capacity. To meet the challenges of constantly increasing perfectionism, the individual must operate in a sphere in which his deepest interests lie in order to use most effectively his basic intelligence and initiative.

"Personal Engineering must be directed most of all toward the assumption of responsibility. Responsibility is a necessary component of all jobs. Even though existing in various degrees and met in many forms, it nevertheless exists in the fully successful performance of any technical as well as operating or management work. Many opportunities exist for assuming the fringe responsibilities of superiors or others, of which they are glad to be relieved. Very few people have either the desire or the talent for assuming large responsibilities without first having administered smaller ones and having worked progressively to larger ones."

Paper Engineering

"Papermaking is one phase of our practical work which it is reasonably safe to assume will never be raised to the level of a science, despite our vastly improved mechanical controls and improved Know-How and skill in the art. This might well become a fertile field for the use of the Engineering thinking approach to gain for us Knowledge in the form of principles approaching generally accepted truth. There exists as yet on this subject no organized correlated principles which we can test out in practical applications analogous to the material we can find in books arising from correlated experience on the other forms of Engineering described above. Largely because of raw material and equipment rigidities imposed on the experience of any individual, he cannot derive principles of papermaking alone. It must be a composite effort to reach any effective degree of validity, which calls for working cooperatively on the paper manufacturing committees of TAPPI to the end that such a body of knowledge of semipermanent validity can be reached.

"If we collectively support such a program for gathering and correlating composite experience together with as much applications of Science as apply, we can produce a field of Paper Engineering analogous to the useful material we have available in some of these other inexact Sciences or fields of Engineering. Through such a procedure we will make our good material more useful and our useful subject matter better. There is much to gain through going forward from the outposts of existing Knowledge rather than continuing to recapture old ground."

Empire State (Metropolitan District)

The Metropolitan District held its regular monthly dinner meeting on Tuesday, April 3, 1951, at Fraunces Tavern, New York City.

Lewis S. Reid, Metropolitan Life Insurance Co., presided as chairman of the meeting. The report of the nominating committee on a slate of officers for the coming year was made by Chester Landes, American Cyanamid Co. The slate was as follows:

Chairman: William R. Willets, Titanium Pigment Co.
Vice-Chairman: Ralph W. Kumler, American Cyanamid Co.
Sec.-Treas.: Jack F. Butterworth, Socony-Vacuum Oil Co.
Executive Committee:
John J. Doherty, Union Bag and Paper Corp.
Robert T. Emerson, Manifold Supplies Co.
Paul L. Haggerty, George LaMonte and Son
Lewis S. Reid, Metropolitan Life Insurance Co.

The entire slate was unanimously elected.

The topic of the evening was "The Economic and Technical Problems of the Waste Paper Industry." This was presented as a series of "off the record" talks by four distinguished leaders in the industry: S. I. Hershman of I. Hershman and Co., New Haven, Conn.; J. A. Culwells, Purchasing Agent, Federal Paper Board Co., Inc.; Anthony Gaccione, Toga Paper Stock Co., New York, N. Y., and C. Baker, Eastern Conservation Committee.

The talks were followed by a spirited discussion. The problem of maintaining a constant supply of uniform paper stock was the most important subject. The mill must depend on the integrity of the collector to ship the same kind of stock year after year. The collector, on the other hand, has the problem of finding uniform sources that he can depend on. The problem of setting fair prices is also a headache. Economic conditions in the community can wipe out a market or create a shortage overnight. Buying and storing waste paper for future use is therefore a hazardous business. From a technical angle, the problem of sorting wet strength papers and resin-coated papers is always present.

WILLIAM LANDES, *Recorder*

May 1 Meeting

The Metropolitan District, Empire State Section, held its regular meeting at Fraunces Tavern, New York City, on Tuesday, May 1. This was the last meeting of the season and was graced by the presence of the ladies who formed about a quarter of those in attendance. The interesting museum of Fraunces Tavern was kept open for the occasion and was visited by most of those present.

Lewis S. Reid, the retiring chairman, presided. On behalf of the group W. R. Willets, the incoming chairman, presented Mr. Reid with a pen-and-pencil set in appreciation of his services. Henry Perry, Chairman of the Empire State Section, said a few words relative to the June meeting at Whiteface Inn and the Empire State Section dinner meeting in Syracuse on May 18 at which the senior students of the Pulp and Paper Department of the College of Forestry will be TAPPI's guests.

The speaker of the evening was Albert D. Osborn, Examiner of Questioned Documents. Mr. Osborn's talk dealt with the scientific examination of questioned documents and was amply illustrated with slides. He clearly demonstrated that the detection of forgeries has been placed on a sound basis by means of carefully laid out comparisons, the use of ultraviolet light to detect alterations and erasures, and by chemical methods. He noted one case in which a document purporting to be dated in 1920 was written on paper having a 1928 dated watermark. He also discussed the restoration of charred documents and currency so that they might be examined and identified. Many interesting and amusing examples were given, in some instances referring to such well-known cases as the Lindbergh kidnapping, the Wendel will case, and the Garrett Estate case, all of which have made newspaper headlines and in all of which Mr. Osborn has acted as consultant.

He referred to the meeting of the American Society of Questioned Document Examiners (which he said had a title almost as cumbersome as TAPPI) in 1948 in which the Institute of Paper Chemistry at Appleton, Wis., and several paper mills were visited.

Following his talk, Mr. Osborn answered a number of questions from the floor. He stated that if his examination of a questioned document involved a detailed chemanalysis or fiber identification he called in a competent paper technologist, but that in general the examination did not call for such tests.

Mr. Osborn was given a rising vote of thanks for his excellent presentation.

W. R. Willets, *Recorder*

Empire State (Northern District)

The need of a public relations program for the pulp and paper industry to acquaint the public with this industry and how it operates was stressed at the spring meeting of the Northern New York District at the Hotel Woodruff on April 12.

The speakers were Henry J. Perry, New York City, editor of the *Paper Trade Journal* and chairman of the Empire State Section of TAPPI; George W. Brooks, Washington, D. C., educational director of the papermaking division of the American Federation of Labor; Homer M. Rice, Organic Chemicals Dept., E. I. du Pont de Nemours Co.

Harold Spector, chemical engineer of the St. Regis Paper Co., chairman of the Northern New York District of Empire State TAPPI, presided, and Horace A. Spencer, technical director of Knowlton Brothers, Inc., served as master of ceremonies.

The meeting was preceded by a dinner at 7 in the back grill of the Hotel Woodruff with an attendance of about 85 technical representatives and superintendents of northern New York paper mills in attendance. The forum was second of a series being held in the state to awaken the industry to the necessity for the creation of an adequate public relations program.

Stressing the fact that the paper industry is the sixth largest industry in the United States, Mr. Perry said that few people know anything about how paper is made. He estimated that

W. B. Morehouse, J. H. Treadwell, T. E. English, L. P. Shannon, H. B. Spector, J. W. Morrow, R. A. Premo, and H. M. Rice

in the last half century there has been an annual average production increase of five per cent.

It was brought out in the forum that the southern wood supply has been drawing the industry south, and that the future of the industry depends largely upon the supply of wood as a pulping material. It was also brought out that at the present time waste paper for repulping and reprocessing into paper is an important material.

The blocking of the establishment of the Panther Mountain water shortage reservoir on the south branch of the Moose River to conserve now wasted run-off waters of the spring freshets to turn into industrial account in the dry seasons, thereby increasing commodity production as well as employee annual pay checks, showed the need of a sound water policy in New York State, Mr. Perry said.

There should also be a sound forest policy in the Adirondacks, he pointed out. There, there is a forest area great enough to afford all of the space recreationists can use and yet leave enough back out of sight to supply the needs of industry.

A map of the state forest preserve, which embraces about 2,400,000 acres, was blocked in with color to show the regions most affected by the hurricane of last Nov. 25, which is estimated by the state conservation department to have knocked down 750,000 cords of pulpwood and billions of board feed of hardwood over a total of 500,000 acres of the forest reserve, was shown to the audience.

Mr. Brooks spoke on the subject of labor relations within the pulp and paper industry and the generally harmonious condition that exists there as between employer and employee.

Mr. Rice related that about a quarter of a century ago he made a survey of all of the paper mills in New York State. Humorously, he told of how at that time he had predicted that in 25 years the paper industry would have dwindled to almost nothing. Today New York is still the largest producing state in the union, he explained, and as against a per capita consumption of 60 pounds of paper a half century ago there is today a per capita consumption of about 350 pounds.

May 10 Meeting

The meeting of the Northern District of the Empire State Section met at the Woodruff Hotel, Watertown, N. Y., on May 10, 1951. The occasion was the annual ladies' night and the attendance was the largest to date with 114 individuals present.

The following were elected to office for the coming year:

Chairman: J. Wayne Morrow, Newton Falls Paper Co., Newton Falls, N. Y.
Vice-Chairman: Richard A. Premo, Gould Paper Co., Lyons Falls, N. Y.
Secretary: T. Everett English, E. I. du Pont de Nemours & Co., Inc., Watertown, N. Y.
Treasurer: John Treadwell, Treadwell Supply Co., Watertown, N. Y.
Executive Committee:
Donald M. Ferguson, St. Regis Paper Co., Deferiet, N. Y.
Thomas Loessi, Latex Fiber Inc., Beacon Falls, N. Y.

Morris Myers, Socony-Vacuum Oil Co., Canton, N. Y.
Roger Schwartz, Knowlton Bros. Paper Co., Watertown, N. Y.
Harold B. Spector, St. Regis Paper Co., Watertown, N. Y.

The speaker of the evening was Louis P. Shannon, Manager of the Eastern District Public Relations Dept., E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., who gave a description and illustrations of the newest textiles and plastics developed by his company. These included nylon and Fiber V, the latter a product similar to wool.

Walter B. Morehouse showed films of the activities at the Empire State Section meeting held in June, 1950, at the Thousand Islands Club, Alexandria Bay, N. Y., and at the TAPPI fall meeting held in 1949 at Portland, Ore.

T. Everett English, *Secretary*

Empire State (Western District)

The Western District of the Empire State Section met at the Prospect House, Niagara Falls, N. Y., on April 4. About sixty individuals attended. Gordon K. Storin, Niagara Alkali Co., Niagara Falls, N. Y., presided as chairman.

At the election of officers the following were elected for the coming year:

Chairman: Irving V. Earle, Upson Co., Lockport, N. Y.
Vice-Chairman: Gordon K. Storin, Niagara Alkali Co., Niagara Falls, N. Y.
Secretary: F. P. Heil, Lockport Felt Co., Newfane, N. Y.
Treasurer: James J. Forsythe, International Paper Co., Niagara Falls, N. Y.

The speaker of the evening was Henry J. Perry, *Paper Trade Journal*, New York City. Under the interrogation of Homer Rice, E. I. du Pont de Nemours & Co., Inc., Watertown, N. Y., Mr. Perry answered a number of questions relating to the current problems of the paper industry.

F. P. Heil, *Secretary*

Empire State (Eastern District)

The March meeting of the Eastern District of Empire State Section was held at Milfranks' Restaurant, Glens Falls, N. Y., on March 15 with about one hundred members present.

The group was especially honored by the presence of R. G. Macdonald, Secretary-Treasurer of TAPPI and editor of *Tappi*. Mr. Macdonald brought greetings from the parent association and outlined some of the program and objectives of the National Association for the coming year.

The program for the evening was on the general topic of "Groundwood Specialties." Three papers were presented by members familiar with various phases of groundwood manufacture and the speakers then acted as a panel to answer questions from the floor. This discussion phase of the program was led by Allen Lowe, Sales Promotion Manager for Sandy Hill Iron and Brass Works, who acted as moderator.

The first speaker was Oscar Anderson, Jr., a graduate of the pulp and paper course, University of Maine, and presently a production apprentice with International Paper Co., Palmer, N. Y. Mr. Anderson's topic was "Preparation of Groundwood for Groundwood Specialties." The second speaker was Clyde Davis, Control Superintendent of Finch, Pruyn & Co., Inc., Glens Falls, N. Y., who delivered a paper on "Process Control." The last paper was on "Bleached Groundwood" and was delivered by Herbert F. Jacques, Chief Chemist of the Pulp and Paper Division of the Diamond Match Co., of Plattsburg, N. Y.

The April meeting of the District was also held at Milfranks' Restaurant in Glens Falls on April 19. The subject for the evening was "Pumps and Pump Troubles." S. H. Grimnes, Chief Engineer of the Pulp and Paper Division of the Diamond Match Co., Plattsburg, N. Y., acted as moderator. Mr. Grimnes is a member of the Mill Design and Economic Aspects Committee of National TAPPI and is collecting data on this subject for presentation at the Engineering Meeting in Savannah, Ga., this fall. Mr. Grimnes preceded the round-table discussion by presenting a complete analysis of the subject. The topic was then opened to discussion from the floor which was stimulated by representatives of various pump manufacturers who had been specially invited. Because much of the material will be presented at the Savannah meeting this fall, no transcript of these proceedings was prepared for publication at this time.

Preparation of Groundwood for Groundwood Specialties

Oscar Anderson, Jr.

Although the actual beginnings of the development of mechanical pulping have long since been enveloped in the shrouds of the distant past, it is reasonably safe to state that the process was first made commercially practical around the year 1850. By 1852 there were two European mills making pulp in Heidenheim and Giersdorf, Silesia, according to a process patented first by Fredrick Keller in 1840 and then bought by Heinrich Voelter in 1846. The first commercial groundwood pulp on this continent was made at the Buntin mill at Valleyfield, Quebec, in 1866, and in 1867 the first groundwood pulp mill in the United States was begun at Curtisville, Mass., by the Pagenstecher brothers. Probably most of you already know that it was these same Pagenstecher brothers who together with a Mr. Miller began building a groundwood pulp mill in 1869 at Palmer Falls, N. Y., on the site of the present I. P. mill. The Pagenstechers brought both their labor and their grinders from their native Germany, and made groundwood pulp according to the process patented by Voelter.

The first groundwood pulp was manufactured at a cost of about 8 cents a pound, but in a few years the price dropped as low as 1 cent a pound. (Nowadays its cost is 2 to 3 cents a pound.) The value of the first groundwood pulp as a constituent of newsprint and printing papers was not immediately recognized, and it wasn't until the 1880's that the newspapers generally approved of newsprint containing groundwood pulp.

Probably the first grinders resembled flour mills with the flat surface of the stone up and the wood ground on this flat surface. Early improvements included mounting the stone on a horizontal shaft and grinding the wood on the stone's periphery as is still done today with most types of grinders. The first grinders, both the vertical and horizontal ones, were direct-connected to waterwheels, and the wood was forced against the stones by hydraulic pressure. Many of today's older mills still use waterwheel-driven grinders, although the most modern groundwood mills have grinders driven by electric motors.

Incidentally, I might point out that ordinarily a big drawback to using waterwheel-driven grinders is that seasonal, and even daily, variations in the amount of water available for power mean that the grinders often have to be run only part time and at speeds which vary. However the groundwood mills on the Hudson River are fortunate in having a regulated flow of water for waterpower, and thus waterwheel-driven grinders on the Hudson, although old fashioned, are still practical as they can be run all the year and at nearly constant speeds.

I won't bother to describe the various types of grinders in detail because time does not permit and because I know most of you are already familiar with them. I'll merely mention

Oscar Anderson, Jr., Production Apprentice, International Paper Co., Palmer, N. Y.

that the types most generally in use today are the hand-fed pocket grinder, the automatic magazine grinder, and a combination of the two known as the Great Northern-Waterous grinder. Grinders that are waterwheel-driven are almost entirely of the hand-fed pocket type. The grinder room at Great Northern Paper Co.'s Millinocket, Me., mill has thirty grinders of the Great Northern type which are so hooked up that some of them can be run on either waterpower or electricity according to the water available. One of Internationals' mills has waterwheels which can be used to run either the hand-fed pocket grinders or generators. In addition these grinders can be run by electricity when the water is low.

Some hand-fed pocket grinders are designed to grind 2-foot wood, some $2^1/_2$-foot, and some 4-foot. Various advantages are claimed for each. Four-foot grinders obviously are capable of greater production per stone, but they are harder to load than 2-foot grinders because of the extra length and weight of the wood. On the other hand, one big advantage of 2-foot grinders over 4-foot grinders is that when regular pulpwood (4 feet long) is cut in two to provide 2-foot sticks for the grinders, it is possible to see exactly just what the condition of the wood is, i.e., whether it is sound wood or rotten. This is especially so when the wood is wet, and such is often the case as the 2-foot wood is often stored in tanks of water (for washing the wood and for increasing the moisture content as well as for convenience) immediately prior to grinding. The opportunity to examine the wood carefully to eliminate the grinding of rotten wood is very helpful in a mill making groundwood for higher grade papers.

In order to explain just how groundwood pulp with certain desired characteristics can be produced, the nature of the stone must be considered. The first stones, and for many years the only stones used, were of natural sandstone, but these stones had many disadvantages which led to extensive experimentation in an effort to find a more practical pulpstone. About 1926 the first synthetic stones were tried in various groundwood mills, and their superiority over natural stones was evident. Today the natural sandstone has all but disappeared from the groundwood mills of the United States. Some groundwood mills still keep natural pulp stones on hand for emergency uses, such as a scarcity of synthetic stones due to wartime restrictions but their eventual use is not considered. One decided disadvantage of the natural pulpstones was their lack of homogeneity, and another disadvantage due in part to this nonuniformity was the possibility of the stones' exploding when being sharpened. The synthetic stones on the other hand are very uniform and do not explode.

Synthetic stones are made of one of two abrasives, either aluminum oxide or silicon carbide. A vitrified bond, which is very similar to procelain in composition, is always used to hold the abrasive particles together. The manufacturer of these synthetic stones can vary the grinding characteristics of his stones by varying (1) the grain sizes of the abrasive, (2) the "structure" or relative spacing of grain particles, and (3) the "hardness" which is a measure of the strength of the bond. A pulp manufacturer can order any combination of these three variables he wants, as well as specifying the abrasive itself. The *stone* manufacturer *can* recommend a stone to give the desired pulp characteristics, but only the experience of the *pulp* manufacturer will determine which combination of stone variables actually produces the desired pulp. When we consider that these synthetic stones often last more than 5 years, the difficulty of determining by experience the correct specifications for a stone becomes evident.

Besides these variables in the pulpstones themselves, the pulp manufacturer has a number of other factors he can vary in an effort to give him the kind of pulp he desires. One is the kind of burr, or sharpening device, he uses for dressing the stone. The four major types of burrs in common use are: (1) the thread burr, (2) the straight burr, (3) the spiral burr, and (4) the diamond point burr. Each of these can be made in any desired size and each produces a different pattern on the stone. Several burrs in succession are usually used in preparing a new stone for grinding.

Operating variables for the pulp manufacturer to determine include the temperature of grinding, the consistency of the stock in contact with the stone, the speed of the stone, and the pressure of the wood against the stone. Most of these are self-explanatory, but I might mention that the consistency is quite easily controlled by adjusting the amount (and the temperature, if possible) of the shower of the water on the stone, and that the temperature of grinding depends upon the other three variables plus the level of stock in the pit.

One more variable which has rather recently been brought to light is the moisture content of the wood being ground. Of course the species and age of the wood being ground also determine the quality of the pulp produced.

It may seem that I have wandered away from the subject of this discussion because until now I have put all the emphasis on "Groundwood" and none on the "Specialties." I did this purposely because I wanted to be able to say at this point that although everything I have said applies to the preparation of groundwood pulp for *all* purposes, it also applies to groundwood for groundwood specialties in particular. That is because the term "groundwood specialties" applies to papers for so many different uses.

Many groundwood specialty papers are to be printed on eventually, and groundwood pulp has characteristics making it desirable for printing papers which no other pulp has. Twenty years ago this made little difference to the printers of higher grade magazines, etc., because the color and brightness of groundwood pulp were poor, but with the advent of groundwood bleaching, groundwood pulp has taken on a new importance. Because of its low cost (compared to chemical pulps), its excellent printing qualities, and (when bleached) its color and brightness comparable to chemical pulps, groundwood is now used in practically all magazine and other high-grade printing papers in furnishes from 40 to 70%. Another recent addition to the groundwood specialty field is coated papers where groundwood is used as a filler.

In conclusion, I would like to enumerate just a few advantages of using groundwood for papers that are known as groundwood specialties: (1) low cost because of high yield of groundwood pulp as compared to chemical pulps, (2) higher machine speeds possible than with "free" stock because easier to dry and less wrinkles and cockles, (3) better formation than with "free" stock because drying slower, and (4) greater resistance to atmospheric changes.

Groundwood Mill Process Control

Clyde Davis

The evaluation of changes made in a paper mill meets with many complications. A mechanical pulp bleach plant provides an ideal example. An attempt is made to control all phases of the bleach liquor make-up and its addition to the pulp. If the pulp brightness goes down, a study of the chemical tests on the bleach liquor and the treated pulp is made to determine the reason for this change. Generally the fault can be found, and the necessary corrections made. When evaluating the effects of these changes, one of the complications encountered is consistency variation. A variation of 0.3% is certainly not a common occurrence but one that does happen. The peroxide is added to the pulp assuming the consistency of the pulp remains constant. When the consistency varies as much as 0.3% from the standard, this change

Clyde Davis, Control Superintendent, Finch, Pruyn & Co., Inc., Glens Falls, N. Y.

means a spread of 1¾ to 2¼% when attempting to bleach at 2% peroxide. This spread based on reproducible laboratory results can by itself make a difference of 1.5 brightness points. In attempting to analyze the results obtained by a change in formula, temperature, or tower holding time, the consistency variation can more than offset any advantage or disadvantage resulting from the corrections made.

Another example of evaluation of changes in a groundwood specialty mill is the effect of treatment of chemical pulp. To a mill that grinds its own mechanical pulp, but purchases its chemical pulp, it is financially important and, in these times of critical shortages of chemical pulp, necessary to continued operation to use small amounts and to get as much benefit as possible from the chemical pulp that is used. With the desired percentages of chemical and mechanical pulps carefully measured to the machine chest, we look to the paper tests for the effect of chemical pulp treatment. If a change in treatment is seen to be necessary from the paper tests, this is made and the effect of this change looked for in the paper tests. In this evaluation we can easily come to the wrong conclusion if there has been a change in consistency of either of the pulps. Assuming that the pulp addition is based on a volume measurement and a standard consistency any consistency variation will change the percentages, and in turn have a pronounced effect on the paper tests in addition to any differences brought about by a change in treatment. This sometimes leads us to think that we have helped the condition that existed but in reality it was only a change of pulp percentages which brought about the improvement.

These examples, incidentally, only two of a long list of variables which affect the paper quality, are brought out to show the need for quality control in paper mills. Without a doubt, if trouble occurs on a paper machine, and one can immediately through control tests or any other means put his finger on the fault, it can be corrected much sooner than if many phases of the process must be investigated before the fault can be found. This shows the usefulness of regular testing of all phases throughout the process which might cause trouble on the paper machine. Consistency, freeness, strength, brightness, pH, acidity tests of the stock must be taken often enough to show variations which might upset the settings on the paper machine. Other materials such as clay, size, and alum must be tested often enough so that irregularities can be spotted before any harm is done. The main advantage of control is to discover irregularities before they cause breakdowns. Instruments play an important part in paper mill control. Controlling instruments, if properly designed for the specific job, can pay for themselves many times over by immediately correcting a condition which might not even be discovered for some time without the instrument. A pH controller at the paper machine is an excellent example of an instrument which pays for itself through a saving of alum, machine wires, all metal parts subject to corrosion, and improved quality of the paper. This is especially true on machines manufacturing sized papers.

While on the subject of quality control I would like to bring out the fact that engineers designing equipment and piping layouts can be of great assistance to the control department. One example of this would be to keep in mind while designing equipment that no variable is introduced into the process that can be avoided. A water-cooled agitator bearing in a chest is perfectly satisfactory when the process is operating normally but can change the consistency if that same amount of water is continued during a temporary shutdown or during fluctuating chest levels. Another example of assistance would be to include in all piping layouts an easy way to sample the work done or the contents of all pieces of equipment.

Perhaps it might be said that one of the major functions of a control department is to seek and record data to locate, reduce, and eliminate process variables which in turn will increase production and improve quality.

Bleached Groundwood

Herbert F. Jacques

Bleached groundwood has a definite and most likely a permanent place in the fiber furnish of the tissue sheets. Prior to the development of the process of bleaching mechanical pulp with peroxide, a high-quality product furnish (for napkin and tissue) would contain no groundwood. The furnish for this sheet would be 100% bleached sulphite.

During the last war, when quantity took precedence over quality, the manufacturer was forced to use unbleached groundwood to replace some of the sulphite. Obviously, the brightness of such sheets suffered considerably.

The advance made in peroxide bleaching technique has made possible the replacement of a part of the bleached sulphite with bleached groundwood. The brightness of the pulp is such that the use of the fiber in reasonable quantities does not too greatly affect the final brightness of the sheet. The softness, absorbency, and aging qualities are, also, satisfactory. Analysis of a number of top quality products in the market at present reveals that as high as 50% bleached groundwood is used. The brightness on these sheets is about, or slightly above, 70.

Spruce and balsam mechanical pulps can be bleached to about a 70 brightness using 2% sodium peroxide.

The same furnish bleached with 1% zinc hydrosulphite will give a slightly lower brightness—66.

Poplar can be substituted for a portion of the spruce-balsam furnish and the resulting brightness will be somewhat higher, about 72 to 73.

Sodium hypochlorite bleach in a 10 to 15% concentration will result in about equal or better to peroxide.

The preparation of the groundwood for bleaching presents no great difficulty. A clean pulp with a low bacteria count is necessary. Thus, good screening and slime control in the pulp mill is very important. It has been found that the peroxide is rapidly exhausted on the bacteria and consequently, less of the bleaching material is available for action in the fiber.

In some cases the use of this bleached groundwood pulp seems to have introduced into the mill system a new and highly resistant type of bacteria. Generally, the usual mill treatment of good housekeeping, chlorinated process water, chlorinated phenols, and mercurics in the stock system will keep the slime in good control. The more resistant type of bacteria may require a high concentration of chlorine close to the point of infection in order to gain control over the slime growth.

Peroxide bleaching seems to have a tendency to free up the stock. A pulp with a freeness of 125 ml. prior to bleaching will have a freeness of about 150 after bleaching, also, the stock seems to drain even better on the wire than the freeness would indicate.

The bleached groundwood sulphite furnish gives no paper machine operating difficulties. The fact that high strength is not as critical in tissue as in some other papers, the use of this short fiber pulp does not adversely affect the finished product. Since very little refining is required in this type of furnish, the low freeness of the groundwood does not affect machine operation to any great extent.

The finished sheet is well filled and of good formation. The bleached groundwood seems to add some softness and considerable absorbency to the sheet. The paper converts well and, despite the increased softness, embosses nicely.

The usual dusting which generally accompanies the converting of such paper in high-speed rewinders can be controlled to some extent by the moisture in the sheet and the humidity of the converting rooms.

Herbert F. Jacques, Chief Chemist, Pulp and Paper Div., Diamond Match Co., Plattsburg, N. Y.

The aging qualities of the finished tissue or napkin is good. The brightness, softness, and absorbency will remain high, well over the usual shelf life of such products.

There is one disadvantage, however, worth mentioning, which always accompanies the use of short fibered stock in a furnish, such as bleached groundwood or hardwoods—the increased loss of the short fiber and fines through the wire. A good saveall and a closed white water system can reduce these losses and keep them at a minimum.

The present sulphur shortage will further increase the use of groundwood, both bleached and unbleached. Less and less sulphite will be available and this deficiency will have to be made up with available fiber. Bleached groundwood is certainly a fiber which has the qualities to replace a good portion of sulphite in the tissue grades of paper.

Question: What is the effect of moisture in the wood on the groundwood that is produced?

Mr. Anderson: Moisture content of higher than 40% means rubbery wood and a resulting lack of resilience in the pulp fibers; a moisture content of lower than 30% means brittle wood and resulting short, weak fibers.

Question: What is the relation between the species of wood ground and the type of pulp it produces?

Mr. Anderson: It was brought out that there was, of course, a difference in yield due to the density of the wood. Aside from that, each wood produces a different fiber and it is desirable for any one mill to always use the same proportions of different species of wood to form its own groundwood pulp. That is, it is not desirable to grind all spruce one day and half spruce and half balsam the next. Balsam and poplar both give softer fibers than spruce, but economic considerations usually demand that a large percentage of spruce be used for groundwood pulp.

Mr. Jacques: With regards to brightness, you can get better brightness on poplar than you do on spruce or balsam.

Question: Unbleached or bleached?

Mr. Jacques: Bleached.

Question: Do you know where hemlock is rated?

Answer: No, I don't know. I would imagine brownish.

Question: Has there been any success in the groundwood field in grinding any of these hardwoods—such as birch or maple?

Mr. Lowe: The panel seems reluctant to answer that. Can anybody from the floor answer that? Does anyone have any recollection of what the results were from grinding real hardwood—like birch or maple?

Member: I can refer you to the report by the New York State College of Forestry in which they discuss their chemigroundwood process and where they have data on the grinding of maple, beech, and birch. Generally speaking, these pulps give very much lower strength than spruce or balsam. They also give you, with maple, a pulp very similar to commercial soda pulp. You obtain a brightness of close to 80, with 3% sodium peroxide. With birch, with 3% sodium peroxide, you obtain a brightness of 72 to 75. Poplar, under that process, gives you higher bursting strength. It will approach the burst of unbleached sulphite, but, of course, you don't have the fiber length and you won't get the tear characteristics. You get a very dark pulp from the chemigroundwood process with poplar.

Member: I think you can get the report this gentlemen referred to, by writing to the State College of Forestry at Syracuse University, and it gives you the facts and figures.

Mr. Lowe: When you speak of chemigroundwood process does that involve cooking the whole log?

Answer: It involves pretreating the log in horizontal digester with sodium bisulphite under high temperature and pressure.

Mr. Lowe: And then it is ground after that?

Answer: That is right. It is ground after the cooking process.

Mr. Lowe: Surely there is a more lively curiosity about the subject of groundwood specialities than has been presented. I would like to know the relation between the horsepower per 24 hour ton and the groundwood that, say, is between 120 to 130 Canadian freeness. Have you any notion about what the horsepower is per ton? That does not bother you any more?

Question: Does the total acidity test show a size variation?

Mr. Davis: We have found out that by running the range of acidity between 110 and 130 on unbleached pulp our sizing seems to be best, and each time we get either above or below that range the sizing suffers. If it gets too high there is too much acidity for the metal parts of the paper machine. Too low an acidity test means the size is not properly set.

Mr. Lowe: I am still puzzled by the lack of concern about the horsepower it takes to make a ton of groundwood. Perhaps I was brought up in an old-fashioned school, but we used to talk about 60-hp. groundwood or 70-hp. groundwood, but now it seems you make groundwood exclusively by freeness, or don't you?

Member: I've heard figures quoted anywhere from 48 up to 60.

Mr. Lowe: I have heard figures quoted up to 100 too, but I will admit that my intimate connection with groundwood was before the days of freeness test and we made groundwood with a blue glass, so maybe we had to have some other test to help us.

Member: With the chemigroundwood they are speaking of, they speak of horsepowers from 35 to 38 per ton.

Mr. Lowe: But they come out with brown pulp, and don't they have to spend some money on it to bleach it?

Member: No, brightness is just about as good as spruce—from 55 to 60.

Mr. Lowe: Does somebody else have a question in line with your power consumption?

Member: What is the relationship between the moisture of either green pulp, or the moisture content in dry pulp with the horsepower required for grinding?

Mr. Lowe: You mean when you are talking about pulp, you are talking about pulpwood?

Member: Yes, pulpwood.

Mr. Lowe: I don't know. Does anybody have any experience with just plain wood, pond-soaked wood, or green wood. I should think green wood would take a lot less power than dry wood, but maybe I am wrong.

Member: We have found that there is a general indication that as the wood becomes more seasoned you use more power per ton because the yield drops off.

Mr. Lowe: Well, that's one answer. More power per ton because the yield drops off.

Member: Is there also a relationship between the fiber and drier wood tending to have a shorter fiber?

Mr. Lowe: I would think you would adjust your sharpening to that, but maybe you don't. I wish somebody who makes groundwood today would get up and answer these questions. I would believe, off hand, that you could compensate somewhat, but in an extreme case I don't see how you could completely compensate for dry wood. Regardless of how you sharpen the stone, you can't compensate fully. With these modern stones where you only sharpen every 3 weeks instead of every 12 hours, you have a different problem don't you?

Member: All I can say to that is that you have to hold a slower freeness to hold the same burst factor as the wood gets drier.

Mr. Lowe: That is you run slower?

Member: Run slower—a duller stone.

Member: Doesn't pressure enter into that?

Member: It could.

Mr. Lowe: You have to juggle three or four things. I think, even with modern equipment and modern stones, you have to juggle a bit with the pressure.

Member: Is the periphery of the stone a critical factor at all in peripheral grinding speed? Do you compensate for it as the stone wears?

Mr. Lowe: Generally speaking, they set up one revolution per minute of the grinder motors and I don't know that they vary that much.

Member: I believe that you will find that with the carborundum stone, or artificial stones, that the wear on the periphery is a relatively small percentage.

Mr. Lowe: What is your answer to that?

Member: We have 55-inch stones and if the stone gets down to 51 inches you can't find any difference between the 51 and 55 inch if it is running 230 r.p.m.

Mr. Lowe: I think it is possible to juggle the other variables to compensate for that, if there is any need to compensate.

Question: I wonder if someone could explain the actual action of the stone on the wood. Is it a shearing action, a tearing action or a rubbing action, or how does the grain in the stone actually convert the wood from a block of wood to pulp?

Mr. Macdonald: At the Montreal meeting, someone tried to answer that question. It was a highly theoretical discussion of what actually happens. Their theory was that the cutting edges, the very small cutting edges, were chisels; and they chisel the wood. That was their theory, but they knew nothing to back it up.

Member: Then you can't take a pulp stone and run it backward and get pulp from it?

Mr. Macdonald: Not according to that theory.

Mr. Macdonald: I would like to ask a question that keeps coming up at the Canadian meetings, where they talk about groundwood more than they do down here. It has never been satisfactorily answered. It may be a trade secret—what difference does it make in the operation of a product if the groundwood you use is wet slush, wet laps, or completely dry? That's been kicked around for 15 years.

Question: Are you speaking of chemical pulp?

Mr. Macdonald: No, groundwood. Operating men have very definite ideas. They don't agree, but they're definite.

Mr. Lowe: To my way of thinking there can be no question but what fresh pulp is preferable because all the power that is expended on it is in making groundwood. If you have got a

very, very, thoroughly dried sheet such as you might transfer from Europe to United States (if there be any such), you have to spend quite a lot of power getting it back to groundwood and sometimes you don't succeed very well without knocking down the structure of the groundwood. My gamble would always be on slush pulp anytime rather than dried sheets. I mean, just from the fact that the groundwood is of the character that you can destroy it by overworking it. A lot of people won't put groundwood through a jordan or morden.

Mr. Macdonald: Some people would give you quite an argument on that. They consider dry or semidry groundwood as being something quite different from slush groundwood and when they formulate the various sheets they consider dry groundwood and groundwood slush as definite separate ingredients.

Member: What is the difference between the quality of pulp you get from using aluminum oxide stone as against a carborundum stone?

Mr. Anderson: The only stone I have had experience with is the aluminum oxide stone. I imagine that either stone can be used to obtain the same quality of pulp by changing some of the other variables.

Member: I would like to know whether anyone has had any experience in adding lime to the groundwood to improve the sizing.

Mr. Davis: In regard to the question about the addition of lime, we did add lime to our pulp to help the sizing effect, but we found out that we had a lot less trouble adding caustic to raise the pH for that effect. The calcium in the lime caused deposits through the mill and was not nearly as stable as the caustic addition, and we got the same results.

Member: We thought lime was the only answer to sizing for 3 or 4 years, but we cut it out and find we get along without it. If something happens, we might have to put it back in. We have never found out the reason but we are not using it now. We are using sodium aluminate in the mixing box. When we used lime, which they say the calcium content will cause trouble, we never had any pitch trouble. We are using sodium aluminate and we're having pitch troubles. Is that an answer? It isn't to me.

Member: I think the question goes a little bit deeper than that. I think there is something about the addition of calcium ion that has some effect on the sizing. I have heard that adding very minute quantities of lime to the groundwood has some effect on the natural pitch of the groundwood to improve the sizing effect. I have no tests to prove this. We added lime to the beater and sometimes we thought it had an added sizing effect and other times we know it didn't. We have been told that the lime has to be added long before the beater—that it should be added at the time the pulp is being made—that is, in the lap form, not the slush form. I don't know whether there is anything to this theory or not.

May 17 Meeting

The final spring meeting of the Eastern District of the Empire State Section of TAPPI was held on Thursday, May 17, 1951.

Featuring the program was a visit to the mill of the International Paper Co. in Corinth, N. Y., in the afternoon. After the mill tour, the group was invited to a showing of a movie "In Partnership with Nature" in the conference room at the plant. This movie, made by the International Paper Co., showed the company's activities in the field of practical forestry.

The formal meeting was held that evening in Milfrank's Restaurant in Glens Falls, N. Y. R. Moynihan, Chairman, introduced Henry J. Perry, Editor of the *Paper Trade Journal*, and Homer Rice, E. I. du Pont de Nemours, Watertown, N. Y. With Mr. Rice as chairman and Mr. Perry as witness, the two put on a program along the current Congressional investigation style. The subject was the "Political and Economic Problems of the Paper Industry" and was devoted primarily to the industry in New York State. This subject is the basis for the annual meeting of the Empire State Section which will be held at the Whiteface Inn, Lake Placid, N. Y.

Mr. Perry, in particular, mentioned the salvage operations now being conducted in the State Forests in the Adirondack Region. By special legislation, operators are permitted to remove the timber which was damaged in the wind storms that occurred in November, 1950. As many know, practical forestry is not permitted on state-owned lands in the Adirondack region. As a result, many trees were mature and so damage was heavy. In contrast, lands which were held by such progressive concerns as Finch, Pryn & Co. which was among the first to utilize the services of a professional forester, suffered little damage. With proper salvage operations and with the example of the paper companies' forestry programs in the area, there is a splendid opportunity to demonstrate what should be and can be done to make the New York State industry independent of an outside wood supply.

Empire State (Central District)

On the evening of May 17, members of the Empire State Section and others interested, met at Drumlins in Syracuse, N. Y., to reactivate the Central District of the section. This district was primarily responsible for the creation of the Empire State Section, but war restrictions on travel coupled with other circumstances led to its dormancy for the last few years. With about 200 persons in the various phases of the paper industry in the area, it is expected that a large, active group will meet regularly starting in the fall of 1951.

Professor C. E. Libby of the State University of New York, College of Forestry, is chairman, and H. D. Cook, Sweet Bros. Paper Co., Phoenix, N. Y., will be vice-chairman and program chairman. Anyone interested will be more than welcome.

The graduating class of the pulp and paper course at the College of Forestry, numbering about 30, were guests of the Empire State Section at the dinner. Because it was the last day of the school year no formal program was arranged so that the students could leave early. Consequently, there were but few remarks from Dean Hardy Shirley representing the College, H. J. Perry, the Chairman of the Empire State Section, R. W. Kumler, Section Representative of the TAPPI Executive Committee, and R. T. Bingham, representing the national offices of TAPPI.

Delaware Valley

The Delaware Valley Section of TAPPI met at the Engineer's Club, April 26, 1951. Chairman Erspamer called for a report from the Tellers' Committee.

J. Harper, Downingtown Manufacturing Co., reported that his committee, consisting of himself, John Steinbinder, Riegel Paper Co., and J. Howard Wright, S. Austin Bicking Co., found that the balloting resulted in an overwhelming vote for the slate as nominated. These are:

Chairman—A. Erspamer, P. H. Glatfelter Co.
1st Vice-Chairman—H. Brill, E. I. du Pont de Nemours & Co., Inc.
2nd Vice-Chairman—Frank Lovegren, W. C. Hamilton & Sons.
Treasurer—E. R. Padavic, Container Corp. of America.
Secretary—Don H. Newcomb, Riegel Paper Co.
Executive Committee—John Macadam, National Vulcanized Fibre Co., and John P. Weidner, Container Corp. of America.

Mr. Harper also notified the group that the fee for dinner will hereafter be $2.25.

Chairman Erspamer informed the group that Mr. Brill will, in the near future, send out requests to the members for their views and preferences for the type of program, topics, and speakers for the meetings of the coming year. He stressed that cooperation in this matter will facilitate greatly the formation of a program which will be most interesting to the group as a whole.

Mr. Brill announced that M. A. Hescock of the Brown Co. will address the May 24 Section meeting on the subject of "Pulp."

Mr. Haug, Program Chairman, introduced the speaker of the evening, Lawrence M. Woodside of the Albany Felt Co. Mr. Woodside has been a Service Engineer with the Albany Felt Co. for the past 15 years. Prior to this, he was with the International Paper Co. for 7 years, serving both in the production and technical departments.

The lengthy discussion period which followed Mr. Woodside's address gave evidence of the members' enthusiastic reception of his very interesting talk.

After the discussion, Mr. Haug expressed his appreciation on behalf of the Section to Mr. Woodside. He also thanked the Section for their cooperation during his tenure in office in the Section and expressed his regret in not being able, due to other pressing duties, to continue to serve as an official of the Section.

Chairman Erspamer introduced G. T. Renegar, Chairman of the Delaware, New Jersey, and Pennsylvania Superintendents' Association. Mr. Renegar reminded the Section of the coming Superintendents' meeting at Easton, Pa., on May 11 and 12 and invited all to attend.

Chairman Erspamer adjourned the meeting. The attendance was 82.

Paper Machine Felts—Their Influence on Papermaking Problems

L. M. Woodside

Felts often play a major part in papermaking problems. In the past, feltmaking was a "rule of thumb" proposition. It was seldom a feltmaker would make the best felt on the first try. He would have to keep changing the felt until he arrived at a satisfactory design. In a sense this approach has been changed. It is now necessary for us, in order to do the best job on any machine, to know nearly as much about that machine as does the man running it. We must make a thorough survey of running conditions, the grades to be made, the finish and openness requirements. This involves a great deal of cooperation and discussion between the feltmaker and the papermaker. But this has paid ample dividends to both.

When you buy a felt these days, you buy more than just a felt. You buy service and machine efficiency. Felts are designed to give good life, but do not sacrifice machine efficiency to get felt life.

We have made concentrated studies of felt application to different problems and to different machines. We have made efforts not only to find out what a felt does under different conditions but why it does these things. It is by these studies that we have changed some of our ideas in making felts. It is only by these studies that we are able to make felts successfully for the higher speed machines and for the machines built with new equipment ideas. Thus far the theories which have been developed, work whether a machine runs 500 or 2000 f.p.m. It is by application of these theories that we expect we will be able to keep up with machine developments in the future, and with the even higher speeds which are in the offing.

To illustrate the problem we have in making a felt for a machine, there are three fundamental characteristics which have more or less equal importance to us and to you as operators. These are: (1) strength, (2) openness, and (3) fineness or finish. To make a felt for any position there must be a balance between these three. Resistance to stretching is of greatest importance in making board and of less importance on an open fourdrinier, but there still must be a balance between the three.

Let us assume that you have a felt which is operating satisfactorily in regard to finish, strength, and openness. Now, let us assume that you speed the machine up from 800 to 1000 f.p.m. and begin to have trouble with the felt filling up. Usually if we increase the openness, finish and strength go down. If you cannot sacrifice any finish, we can hold it and improve the openness but usually with a greater sacrifice of strength.

This is not quite so bad as it looks. Here is where our research has paid off. We can, in some cases, change the design of the felt so you can have all three improvements.

When you make machine changes, you will eventually reach a point where a felt change will have to be made. We have had many mills in the recent years where machine speeds have been increased by small steps for a year or two. All at once, with a further increase of only a few feet, they start having trouble with felts stretching, felts filling up, felts running narrow, or with any number of other troubles. In these cases it is the old story of "the straw that broke the camel's back." You should make frequent appraisals of your machine set up to determine not what a minor change has done, but what the minor changes you have made add up to. If you do not do so, you may suddenly find your machine giving trouble, and it will remain in that state until a felt is designed to operate under the new conditions.

I do not presume to tell you that the felts are never at fault when you have trouble. I would like to say though, when we design a felt for a particular machine we try to build into that felt a margin of safety in regard to strength, openness, and finish, so that your variations and ours, will not allow that felt to give you trouble. Our standards for a certain felt range between specified tolerances. Your variations in machine operation also have a range. As long as our standards and your variations are in proper relation you will have no trouble. But, for example, if our tension gets a bit on the low side of the allowable variation, your pull gets on the high side, so the two ranges overlap—Look Out!

If we know about this trouble, even though it be minor, we can revise our standards and you should have no more trouble. Of course it helps too, if we know when you are going to improve your machine, install new drives, more suction equipment, or other equipment.

From this discussion, I am sure you realize that we, as felt men, believe in a good maintenance program in any mill. A felt is designed to operate under a set of conditions. The margin of safety allows flexibility so the felt will operate properly even if those conditions are not maintained exactly as when the machine was first surveyed. For best results with your felts, the machine should be kept in at least as good condition as when surveyed.

There is a great deal to be done to improve cleaning of felts. The easiest way to do this is, of course, not to let the felt get dirty. More and more mills are working toward programs where they do not have to wash felts, or where washing is more or less of a minor job. The use of felt conditioners, suction boxes, showers, and whippers has cut down a great deal of the trouble with dirty felts. There are still some mills, however, particularly fourdrinier machines, where washing of felts is quite a chore.

There are any number of good washing compounds on the market. I might caution you that you should be sure you use the proper one to do your job. Once, we made recommendations to a mill that they clean their felts by using a muriatic acid wash, followed by a rinse and then a soda ash and soap solution. This worked well for a while, but then was reported as no good. Investigation brought out, from the man who was in charge of felt washing, the remark that the acid was good and the soap and soda ash was good, so he mixed the two solutions!

One of the outstanding new developments is the use of nylon in papermaker's felts. Nylon is excellent in resisting frictional wear, and it is probable that there is considerably more of this wear on the faster running machines. Further, nylon creates problems of yarn manufacture and of feltmaking which are not always a benefit to the felt. In certain felts, nylon content has proved a benefit.

L. M. Woodside, Service Engineer, Albany Felt Co., Albany, N. Y.

I believe the important thing to remember is that nylon will improve the strength of a felt but in order to use it successfully, it is necessary to have a properly designed felt at the start. There are the same problems of application of a felt to a machine, whether it has nylon in it or not, and the felt must be made to operate under those conditions.

Paper mill technical men are becoming more and more interested in a felt program. This need not be greatly involved, but should serve as an advisory service to your feltmaker. Practically all paper mills keep track of their felt performance in felt cost per ton of paper made. It is good to keep this record but it must be remembered, particularly now, that you are primarily interested in the amount of good paper that is shipped out the front door every day. Felt cost per ton is not always a good measure.

A very few mills keep track of machine efficiency while each felt is on. This should be the true measure of the value of the felt. In a board mill a few years ago, we were able to plot the gain in production by using a more open, lighter weight felt which allowed highest production all during its life rather than the gradual slowing down caused by the heavier felt. In these figures, with a lighter weight felt running only two thirds as long as the heavier felt, figuring in down time along with everything else, it was found that the higher efficiency made a profit of $137 per day. This has been further proved in many other mills.

Again, in several mills, it has been found that by changing clothing all at the same time, they have saved money. In a board mill I know, they cut off top, bottom, and two press felts whenever the bottom felt wears out. In this way, they have only one shutdown every 3 weeks which has paid tremendous dividends.

The important thing to keep track of, in a felt record, outside of efficiency or cost, is the manner in which a felt wears out or why it is removed from the machine. If, for instance, you find you are removing felts because they are filled up and cannot be cleaned, the feltmaker can probably make a felt which will improve this condition.

You should study the removed felt to see whether it is the warp or filling yarns that are failing. Of course, if this occurs in felt after felt in one general area, such as edges, there is probably a bad roll some place on the machine. If, however, the wear is general, and is on the warp or filling yarn, the feltmaker can possibly strengthen the yarn which is giving trouble, to give you better life, better performance, or both.

Question: Does nylon affect the stretch of felts?
Mr. Woodside: In view of the manner in which we design and manufacture nylon content, stretching is not a problem.
Question: What are the limitations of shower pressures in particular reference to a board machine?
Mr. Woodside: Shower pressures up to 140 pounds have been used without damage to the felt. At least 75 pounds available pressure is recommended. Jet-type showers are not recommended.
Question: Do fillers used in furnishes affect the life of the felt?
Mr. Woodside: They do definitely. Carbonates are worse than clay. Sulphites are very bad.
Question: What are the felt problems where the paper is treated with wet-strength agents?
Mr. Woodside: Wet-strength papers often are troublesome from the felt standpoint. The wet-strength agent fills up the felt to a degree, naturally giving the effect of a close felt. Changes in the design of the felt are sometimes successful in eliminating this undesirable trait.
Question: Is a nylon felt difficult to trim?
Mr. Woodside: Yes. In trimming a nylon felt great care should be taken, and the use of a knife is recommended.
Question: What should be the temperature of the water in felt conditioners?
Mr. Woodside: Less than 120°F. is recommended. If a felt is designed to give extra strength, a higher temperature can be used.
Question: What pH is recommended for shower water?
Mr. Woodside: Water on the alkaline side, i.e., pH 8 or higher, is not recommended. For one thing, bacterial growth is enhanced at the high pH.

LETTERS TO THE EDITOR

Japanese TAPPI

To the Editor of *Tappi:*

I wish to tell you about some of the recent activities of the Japanese Technical Association of the Pulp and Paper Industry, of which I am President.

Succeeding I. Nishi, President of the Jujo Paper Manufacturing Co., Ltd., I assumed the presidency of this Association last April. In this capacity I have been doing my best to help promote and improve the technical phase of the industry in Japan through our Association.

Fortunately, we have been directly or indirectly assisted by Harold Murdock, who has returned to the States; Carl B. Barnes, who is now in charge of pulp and paper at the Economic and Scientific Section, GHQ, SCAP; Frank J. Spinar, who was in charge of pulp and paper at the Natural Resources Section, GHQ, until July, and many other persons connected with the industry.

Our membership now comprises over 1700 corporate and individual members, and the circulation of our Association Journal is about 1800 copies. We have seven committees, including the Committee for the Research of Standardization of Pulp and Paper Testing Methods and the Preparatory Committee for Establishment of Standards in Conformity with the Japanese Standardization Law. All of the committees are doing creditable work.

We occasionally hold meetings to hear lectures by highly experienced technicians of the industry.

To encourage technical improvements, we set up a system of awards and prizes somewhat similar to TAPPI in the United States. Thus, we are endeavoring to contribute something to the betterment of techniques in Japan's pulp and paper industry.

As you may be aware, there are many things calling for our redoubled efforts, since equipment, machinery, etc., of the postwar industry over here requires repairs, and in many cases requires renovation or replacement and our technology is quite far behind that in the United States. In this respect, I believe that our industry will have to rely on further guidance and assistance in the future. Your continued cooperation, of course, will be highly appreciated by our Association.

Yoshikuiu Seki, *President*
Japanese TAPPI, Tokyo, Japan

ALKALINE PULPING CONFERENCE
John Marshall Hotel, Richmond, Va.
Sept. 26–28, 1951

SIXTH ENGINEERING CONFERENCE
General Oglethorpe Hotel
Wilmington Island, Savannah, Ga.
Oct. 15–18, 1951

Specification for Chromium-Nickel-Iron Alloy Castings for Sulphite Pulp Processing Equipment

Revision of TAPPI Official Standard E 400 s-43

(THIS SPECIFICATION IS UNDER THE JURISDICTION OF THE MILL MAINTENANCE AND MATERIALS COMMITTEE)

This specification covers chromium-nickel-iron castings used for sulphite pulp processing, such as relief valves, strainers, pumps, digester fittings, etc.

PROCESS

Alloys shall be made by the electric-arc, electric-induction, or other commercially approved processes.

HEAT TREATMENT

Castings shall be heat-treated according to the requirements shown in Table I, unless otherwise agreed upon by the manufacturer and purchaser.

CHEMICAL COMPOSITION

Alloys shall conform to the requirements as to chemical composition prescribed in Table I.

LADLE ANALYSIS

An analysis of each melt shall be made by the manufacturer to determine the percentage of the elements specified in Table I. The analysis shall be made from drillings taken not less than 1/4 inch beneath the surface of the test ingot made during the pouring of the heat. Chemical composition shall conform to the requirements prescribed in Table I and, when specified in the inquiry, contract, or order, shall be reported to the purchaser or his representative.

Table I. Chemical and Heat Treatment Requirements

TAPPI grade	*1*		*2*		*3*	
ASTM A 296 grade	*4*		*...*		*9*	
A.C.I. grade	*CF-8M*		*CF-8M3*		*CE-30*	
	Min.	*Max.*	*Min.*	*Max.*	*Min.*	*Max.*
Carbon, %	....	0.08	....	0.08	....	0.30
Manganese, %	....	1.50	....	1.50	....	1.50
Silicon, %	....	1.50	....	1.50	....	1.50
Phosphorous, %	....	0.05	....	0.05	....	0.05
Sulphur, %	....	0.05	....	0.05	....	0.05
Chromium, %	18.0	21.0	18.0	21.0	26.0	30.0
Nickel, %	9.0	12.0	9.0	12.0	8.0	11.0
Molybdenum, %	2.0	3.0	3.0	4.0	....	.....
Heat treatment	Rapidly cooled from 1950°F. min.		Rapidly cooled from 1950°F. min.		Optional	

CHECK ANALYSIS

An analysis may be made by the purchaser from a broken tensile test specimen or from a casting representing each melt. Drillings for analysis shall be taken not less than 1/4 inch beneath the surface, and in such manner as not to impair the usefulness of any casting selected. The chemical composition thus determined shall conform to the requirements specified in Table I.

TENSILE PROPERTIES

Tensile properties are not required unless they are specified in the inquiry, contract, or order. When so specified, properties obtained shall be reported to the purchaser or his representative and shall conform to the requirements prescribed in Table II.

Table II. Minimum Tensile Properties

Grade	*1*	*2*	*3*
Tensile strength, p.s.i.	70,000	70,000	80,000
Yield point, p.s.i.	30,000	30,000	40,000
Elongation in 2 inches, %	30	25	10

The methods of tension testing and number of tests and retests, when required, shall be in accordance with requirements of ASTM Specification A 296–49 T, unless otherwise agreed upon by the manufacturer and purchaser.

HYDROSTATIC TESTS

Pressure castings made to this specification shall be individually tested, after final machining or assembly, to pressures as agreed upon by the manufacturer and purchaser and shall show no leaks.

NONDESTRUCTIVE INSPECTION

If specified in the inquiry, contract, or order, and when mutually agreed upon by the manufacturer and the purchaser, castings made to these specifications may be subject to radiographic or other methods of nondestructive inspection.

Methods of procedure and number of pieces and areas to be inspected shall be agreed upon by the manufacturer and the purchaser.

Inspection standards and procedures are to be mutually agreed upon by the manufacturer and purchaser.

Note: A.S.T.M. (E-71) Radiographic Standards are recommended as a basis for acceptance.

WORKMANSHIP

All castings shall be made in a workmanlike manner

and shall conform substantially to the dimensions on drawings furnished by the purchaser before manufacture is started, or if the pattern is supplied by the purchaser, to the dimensions predicated by the pattern.

FINISH

The castings shall be free from injurious defects, and shall be satisfactorily cleaned for their intended use when offered for inspection.

Minor defects that will not ultimately impair the usefulness of the castings may be welded by an approved process. The composition of the deposited metal shall approximate that of the casting itself; otherwise the composition used in welding shall be subject to agreement between the manufacturer and the purchaser. Defects shall be considered minor when the depth of the cavity prepared for welding is not greater than 20% of the actual wall thickness but in no case greater than 1 inch. Minor defects may be welded without securing the approval of the purchaser, whereas defects other than minor may be repaired only with the consent of the purchaser. Heat treatment in accordance with Table I shall follow welding.

Unless otherwise specified in the inquiry, contract, or order, all castings intended for corrosion-resistant service shall be finally blasted with clean sand or metallic corrosion-resistant shot, or pickled.

MARKING

When specified by the purchaser, the manufacturer's name or identification mark and the pattern number shall be cast or stamped on all castings, except those of such small size as to make such marking impractical. For the prevention of small defects caused by dislodged particles of molding sand, there should be provided the minimum feasible number of cast identification marks. The marking of melt numbers on individual castings shall be subject to agreement by the manufacturer and the purchaser and so stated in the inquiry, contract or order.

INSPECTION

The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacturer of the material ordered. The manufacturer shall afford the inspector, without charge, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications.

All tests (except check analysis) and inspection shall be made at the place of manufacture prior to shipment unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

If in the case of important castings for special purposes surface inspection in the green state is required, this shall be so specified in the inquiry, contract or order.

REJECTION

Unless otherwise specified, any rejection based on tests made in accordance with these specifications shall be reported to the manufacturer within 5 working days from the receipt of samples by the purchaser.

Material which shows injurious defects following original inspection and acceptance at the manufacturer's works will be rejected and the manufacturer shall be notified.

REHEARING

Tested samples representing rejected material shall be held for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

Forming Structural-Type Boards for Physical Tests of Pulp

TAPPI Suggested Method T 1001 sm-51

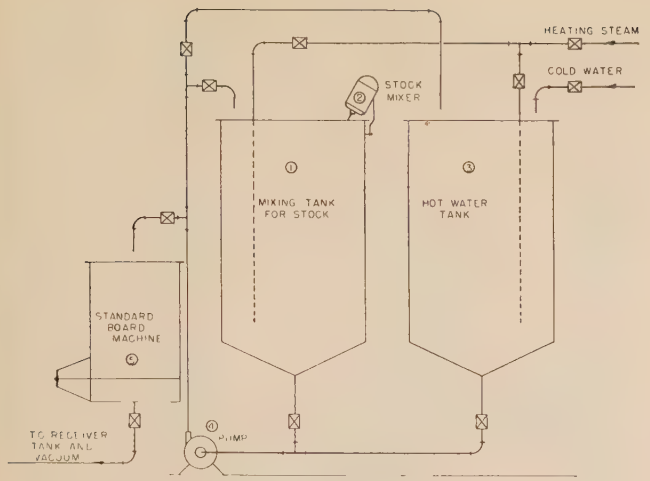
(THIS METHOD IS UNDER THE JURISDICTION OF THE STRUCTURAL FIBROUS MATERIALS COMMITTEE)

A SPECIFIC method is here presented for the preparation of test board for the evaluation of pulps for the purpose of making structural-type boards. The physical properties resulting from the use of the pulp under examination are determined from the test board by test methods as specified in TAPPI Tentative Standard T 1000 m, Commercial Standard CS 42–49, and Federal Specification LLL-F-321b. The procedure presented here requires test boards be prepared at four varying densities. Using these standard test methods, four moduli of rupture (or adjusted breaking loads) are obtained and the results plotted against density. A "usual dry density" is selected by experience and transverse strengths and all other physical properties determined at that density.

The term Usual Dry Density is used in this procedure to designate any moisture-free board density which is about normal for the type of pulp under test. Thus, usual dry density could mean a dry-board density varying from approximately 15 to 22 pounds per cubic foot. In a given mill a board pulp would be expected to produce a certain customary or usual density and the term usual dry density at that mill would be that customary density.

This method for test-board formation applies only to pulps of a freeness range customarily found in pulps used for structural types of boards which are normally made from $^3/_8$ to 1 inch in thickness. The method may be used where some variations of structural-type boards exist, such as when resins or bituminous binders are a part of the board.

The stock used for the preparation of the test board



NOTE: GRAVITY ARRANGEMENT MAY BE USED IF CEILING HEIGHTS ALLOW.

Fig. 1. Typical forming equipment arrangement

by this procedure may or may not be sized. The subject of sizing has not been included in the method, owing to the diversity of sizing materials and processes in common use for the manufacture of structural-type board.

APPARATUS

1. Stock Mixing Tank. A cylindrical tank 30 inches in diameter and 36 inches high, with a flat (20°) cone bottom; fitted with three vertical baffles projecting 2 inches into the stock, 120° apart on the inside circumference, and a direct steam-heating injector or other suitable stock heater. The capacity of the tank is about 15.5 cubic feet.

2. Stock Mixer. A "Lightnin" mixer, Model S3, 1725 r.p.m., $^3/_4$ hp., with a 5-inch diameter three-bladed propeller, is satisfactory. It should be placed in the mixing tank so that horizontal, circular stock motion is avoided, and with the propeller near the bottom to avoid foam in the last boards made.

3. Hot-Water Tank. A tank similar to the stock mixing tank, equipped with water inlets and outlets and direct steam or other suitable water-heating system.

4. Stock Pump, Piping, and Valves.

5. Standard Board Machine. A TAPPI standard SFMC board machine as shown in Figs. 2a and 2b. It is provided with three deckle heights, 15, 23, and 31 inches, respectively, to allow adequate yet not unnecessarily high deckles for consistencies of from 0.70 to 2.00%. The standard deckle height is 31 inches.

Note: A typical arrangement of the above items is shown in Fig. 1.

6. Standard Stirrer. A circular plate, 7.5 inches in diameter and $^1/_{16}$ inch thick, of brass, stainless steel, or iron, perforated with sixteen 1-inch round holes at random, and a handle of $^1/_2$-inch round rod or pipe welded or otherwise fastened at right angles to the perforated plate. The handle is made in three lengths, approximately 24, 36, and 48 inches, respectively, for use with the three deckle heights. The 48-inch length is the standard.

7. Vacuum Pump. A Nash No. 2, with controls to maintain a 15-inch mercury vacuum, is suitable. Other means for providing a vacuum will be satisfactory if the correct negative pressure is provided throughout the test.

8. Receiver Tank. A closed tank between the board machine and the vacuum pump to assist in maintaining the 15-inch vacuum with free-draining fibers. If adequate vacuum source is available without a receiver tank, the tank may be omitted.

9. Plates. Several stainless steel plates, 14.5 inches square and $^1/_8$ inch thick.

10. Screens. Several screens, 14.5 inches square, made of 0.0156-inch diameter bronze wire with 16 meshes to the inch in each direction.

11. Press. Any press that has a capacity for 70,000 pounds total pressure and is capable of developing pressures at the specified speeds is satisfactory. The press platens must be large enough to accommodate the test board, plates, and screen assembly without overhang of any part of the assembly. A $^1/_2$-inch high platform, 14.5 inches square, shall be provided on the bottom platen to keep the test board clear of drainage water at all times.

12. Board Drier. A forced-air circulating oven is preferred, capable of drying at one time 12 test boards in less than 5 hours. A drying temperature of 300 ± 10°F. shall be provided.

13. Scale. Any suitable scale capable of weighing a test board to 0.5 gram.

SAMPLING

Sampling shall be done so that the pulp used for the preparation of test boards is representative of the entire quantity under examination. The quantity of fiber required for one test is about 25 pounds, dry weight, including fiber for possible preliminary trial boards.

MOISTURE CONTENT

Determine the moisture content of the test pulp, using a representative sample of about 0.5 pound and drying to constant weight at 215 ± 5°F.

TEST BOARDS REQUIRED

A full test requires four test boards, each made at a different specified press pressure and in triplicate, making a total of 12 test boards. The test board size is 14 inches square, with a plus tolerance of 0.5 inch, and the thickness, when dry, shall be 0.50 ± 0.05 inch. Four preliminary test boards may be required when fiber characteristics are uncertain.

PROCEDURE

Preparation of Stock

Dry pulp shall be soaked in water until wet through before placing in the mixing tank; damp or wet pulp may be introduced directly into the mixing tank.

Place in the mixing tank moist pulp of known moisture-free weight sufficient for the test boards to be made, plus 10%, together with a quantity of water to bring the consistency to approximately 3%. Raise the temperature to 100 ± 5°F. with direct steam injection or other suitable means. Start the mixer, and when the stock is well dispersed, add more water at 100°F. from the hot-water tank to bring the consistency to the exact 2% essential for accurate volumetric measuring of the amount of fiber for a test board.

The hot-water tank should be refilled and heated to 100°F. while mixing in the mixing tank is being completed. When the stock is well mixed, at the 2% consistency, boardmaking is begun and the mixing continued throughout the operation. The point at which boardmaking can be started is judged by observation of a dilute sample of the stock for thorough fiber dispersion.

Notes: (1) A temperature less than 100°F. may be used for noncontroversial testing to conform to mill temperatures.
(2) If desired, the stock may be prepared directly at 2% without the first preparation at 3% consistency; but a larger mixing tank will be required.

Test-Board Making

Fill the suction box and deckle of the board machine with water at 100 ± 5°F., from the hot-water tank or other suitable source, to a height inside the deckle that will provide the stock consistency to be used between 0.70 and 2.00% when enough 2% consistency stock to form one test board is added from the mixing tank. Carefully stir the stock in the board machine deckle, using the standard stirrer, in such a manner that rotary motion of the stock in a horizontal plane is minimized, and violent stock currents will not be present to persist for some time after stirring is stopped. When the stock in the board machine is uniformly mixed, stop the stirring, and after agitation of the stock has quieted, apply a vacuum of 15 inches of mercury and maintain until all water has disappeared from the board surface and the mat begins to part from the deckle. Then shut off the vacuum, remove the deckle and place a steel plate on top of the mat.

Reapply a vacuum until any further obvious reduction in mat thickness has ceased; shut off the vacuum,

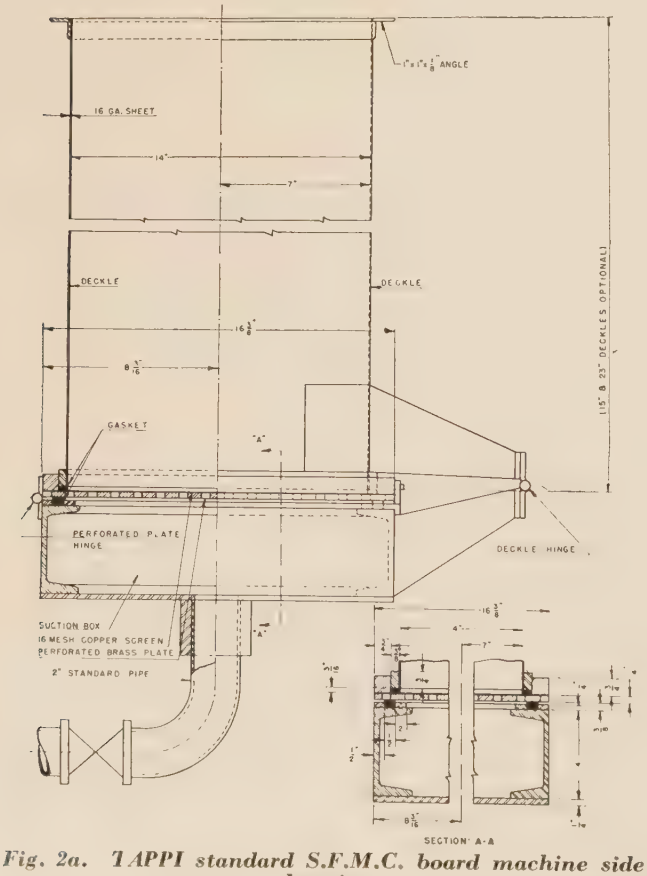


Fig. 2a. TAPPI standard S.F.M.C. board machine side elevation

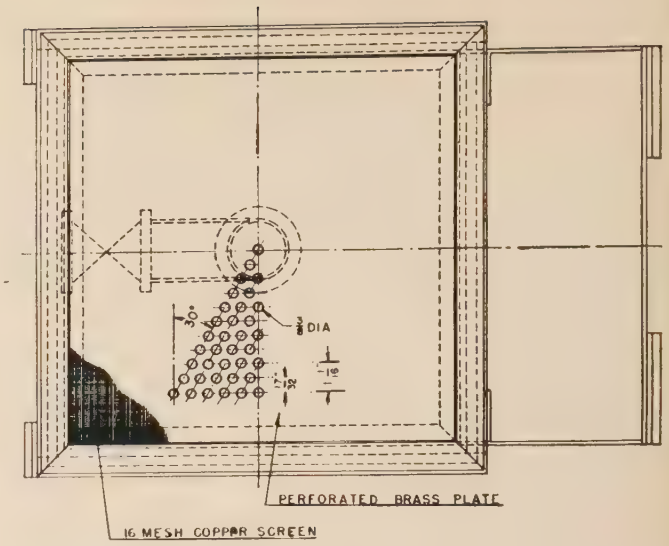


Fig. 2b. TAPPI standard S.F.M.C. board machine top view

remove the steel plate, place a screen on top of the mat, and return the steel plate. Rapidly turn over the mat, top screen, and plate by rotating the hinged board-machine filter leaf and separate the mat from the leaf. Place a second screen on top of the inverted mat and a steel plate on top of the screen. The mat is now faced on both sides with screens, with steel plates over the screens.

Pressing

Place the mat, screens, and plates in the press, resting on the press platen, and apply pressure at the specified standard rates of 2.5 pounds per square inch (p.s.i.) per second for the lowest standard pressure, and 5 p.s.i. per second for all other standard pressures. Hold the specified pressure for 30 seconds to allow drainage, then open the press.

Standard maximum pressures shall be 50, 100, 200, and 350 p.s.i. applied to the surface of the test board.

Drying

Weigh each of the test boards, place them in an oven with heated, circulating, and replaceable air, and dry at 300 ± 10°F. until the loss in weight of a test board after 15 minutes further drying is not more than 1 gram. The test board is then considered to be dry. If a tendency to warp becomes evident, due to uneven drying of the surfaces, turn the test board over frequently enough to retain a substantially flat condition until dry. Drying shall not require more than 5 hours.

Preliminary Trial Boards

To establish the quantity of fiber that will be required to produce a usual dry density at one of the standard pressures, a preliminary trial may be necessary. This requires four test boards to be made, one at each of the four standard pressures.

By judgment and other means, such as freeness, select one of the standard pressures estimated to produce a usual dry density test board. The quantity of fiber at the selected pressure shall be based upon the usual dry density at a 0.50-inch thickness. The quantity of fiber for boards made at the other three standard pressures

may be increased or decreased about 5% in weight for each increasing or decreasing standard pressure.

Prepare a weight of fiber at 3%, then 2% consistency, as defined above, with an excess of 25% to provide sufficient stock for making the four trial test boards. Make and dry the four test boards according to the standard procedure. From the thickness and densities of these trial test boards, adjust the fiber quantity to provide a test board thickness of 0.5 inch at the four standard pressures.

Conditioning

Remove the dried test boards from the drying oven, stand them on edge separately to cool, and then condition for at least 24 hours in an atmosphere of 70 ± 3.5°F., and 50 ± 2% relative humidity.

Note: Other cooling conditions may be used for general testing; for cross checking and controversy, the specified conditions shall be observed.

Care and Storage of Wax

The proper care and storage of petroleum wax is easily accomplished. It is when simple rules are overlooked that wax becomes difficult to handle or even unfit for use.

Last year (1949) the petroleum industry shipped 898,240,000 pounds of wax, and at the current rate of production it will ship about 1.1 billion pounds this year. About 61% of last year's production was refined wax, 33% crude scale wax and 6% microcrystalline wax. Approximately the same percentages apply to waxes shipped during the first 3 months of 1950.

Wax is usually shipped in top-grade condition. The Esso Standard Oil refineries, in particular, exert every effort and take every precaution to insure this condition.

It is of utmost importance to users that wax be received in good condition, having successfully withstood the rigors of transportation, and that, when handled and stored properly, it will remain usable for prolonged periods. The methods used by Esso Standard Oil in wax packaging and packing are designed with these considerations in mind.

Further responsibility for avoiding quality deterioration through exposure of the wax to contaminating influences then devolves upon the user.

Waxes are shipped from the refineries in solid and liquid forms. Refined and some microcrystalline waxes are shipped in slab form. Slabs of refined wax are packed about 96 net pounds (9 slabs) to a carton and slabs of some microcrystalline waxes are packed 8 to the carton, each slab weighing about 10 pounds. Burlap bags also are used to ship refined wax. These bags contain 220.5 pounds of wax.

Some refined wax is shipped "slabs loose" in railroad cars and trucks. Rail and truck shipments are also made on expendable pressed-paperboard pallets. When shipments of slab wax are made in very hot weather, the cars and trucks are refrigerated to prevent the slabs from adhering to one another before they reach destination.

Crude scale wax is shipped in slack barrels (400 pounds net). In this case the wax is poured into the barrels and the latter broken open by users. Crude scale wax also is poured into cylindrical, paperboard containers (85 pounds net) and some special waxes are poured into bulkans, a coined word for containers like ice-cream cans, holding approximately 32 pounds.

The refineries also ship large quantities of wax as a liquid in tank cars and tank trucks. These cars and trucks are equipped with steam coils so the solidified portion of the wax can be melted at destination.

Almost 80% of the wax produced in this country is used by the paper industry. Milk cartons and bread wrappers are the largest individual wax consuming applications.

Large quantities of waxes are also consumed in industries producing candles, polishes, crayons, impregnated fabrics, chewing gum, matches, rust preventives and other products.

In these instances, as in practically all wax applications, it is necessary that wax be clean, free from any objectionable odor or color, and be of correct melting point. In some cases, as in milk-carton waxing machines, the slabs of wax must be of certain dimensions so they will be able to fit the machine's wax tank.

Wax-consuming industries desire to handle and store waxes so they will be put to use in the same condition in which they were shipped from the wax refinery. To accomplish this, consumers' plants must be careful to protect these petroleum products against excessively high temperatures, against prolonged exposure to sunlight, against exposure to dust and dirt, and to atmospheres which may contaminate the waxes by imparting odors. Waxes also may be contaminated by products employed in wax-using plants. Among such products are lubricating oils, solvents, and dirty steam. The catalytic action of nonferrous metals on waxes may adversely affect them.

It should be quite obvious to wax users that every effort should be made to store wax so that no dust, dirt, or odors can reach it. If containers are broken when they are moved into a plant from delivery vehicles, the wax should be used immediately to prevent contamination or it should be covered so contaminants cannot reach it. Liquid waxes should be pumped to storage and other vessels in pipes having a minimum number of nonferrous metal connections or no such connections, because these metals may act as catalysts and cause wax oxidation.

Some provision should be made for stacking cartons or other containers off the floor. Pallets or raised flooring are used to avoid having the containers rest directly on the floor, from which they can pick up water, moisture, dirt or other contaminants. Burlap bags permit sifting of dust and dirt from some floors and from storage areas which are known to contain large amounts of dust and dirt. Cylindrical wax containers should be placed on end when stored, rather than on their side.

Although not generally realized, waxes in storage have a tendency to pick up odors from the atmosphere. Odors from chemicals, foods, growing plants, like onions, and garbage odors may be picked up by wax. Even musty cellar odors are often acquired by stored wax, especially if the containers are broken open and the bare wax slabs are exposed to surrounding air.

The storage area within the plant should preferably have a temperature of about 70°F. or lower. Maximum safe storage temperature of wax slabs obviously has some relationship to melting point. Slabs of most waxes can be stored at temperatures well above 70°F. for short intervals, and some high melting-point waxes may safely be stored indefinitely at temperatures higher than 70°F. Excessively high temperatures in storage areas, however, may cause slabs of wax to adhere to one another, thus making it necessary to spend time prying slabs apart or, in extreme cases, cutting proper size blocks from the mass. Some milk-carton-waxing machines cannot accommodate more than 1 slab of refined wax. Wax-melting tanks in other plants are designed to hold only a certain number of slabs at a time.

Another matter is the effect on molten waxes of temperatures high above their melting points. It is impossible to formulate general rules covering all waxes, but safest practice is to store liquid waxes at temperatures as close to their melting point as convenient, to apply wax at the lowest practical temperature, and to reduce wax bath temperatures to slightly above the melting point when waxing machines are not in operation.

When waxes are held at prolonged high temperatures, they discolor and acquire an objectionable odor, which are results of oxidation. All waxes are susceptible to oxidation if the high temperatures are prolonged. In this respect care must also be taken to avoid localized overheating. Some waxes will become unfit for use if held at 250°F. for 24 hours or at a lower temperature for a longer period. Most wax users are aware of the oxidizing properties of wax at elevated temperatures, and when necessary to apply wax at very high temperatures many concerns add an oxidation inhibitor.

In addition to keeping wax at proper temperature, it is important that it be protected against prolonged exposure to sunlight. Sunlight not only has a tendency to produce surface discoloration but, more important, it tends to cause development of an odor in the wax. In plants equipped with fluorescent lights in storage rooms, ultraviolet from the lamps may, in time, cause wax discoloration and bad odor.

Microcrystalline waxes, stored as a liquid for prolonged periods, sometimes deposit a sludge. Trouble from this source may be minimized by using several small tanks instead of one large tank. It is easier to schedule cleaning of the smaller tanks, and withdrawals can be arranged so that each tank, in turn, is emptied. Any small amount of sludge in these tanks can be drawn off periodically without much trouble. If the sludge is allowed to remain in a tank, it has a tendency to cause oxidation of the wax. In some plants liquid wax is filtered before being used to be sure no sludge is carried to machines.

Care should be taken that waxes are not allowed to pick up lubricating oils from machines in which they are used. This is a problem of preventing lubricants from dripping or slinging from moving parts into the wax. If solvents are used in a plant, care should be exercised that none reach the wax to contaminate it. In some plants in which wax is heated in storage tanks, the steam pipes in the tanks may develop leaks and cause dirty steam to reach the wax. Clean steam will settle and can be drawn off, but dirty steam often leaves some of its solid matter in the wax, and it frequently imparts an odor to the wax.

In brief, wax users should store wax so it does not acquire contaminants and be exposed to high temperatures and sunlight.

From Esso Oilways, September, 1950

RECENT BOOKS

Encyclopedia of Chemical Technology. Vol. 6. Edited by Raymond E. Kirk and Donald F. Othmer, Polytechnic Institute of Brooklyn. The Interscience Encylopedia, Inc., New York, 1951. Cloth, $7^1/_4 \times 10^1/_2$, 1008 pages. Illustrated. $20.

This remarkable set of ten volumes has now passed the halfway mark. Many editors have urged the publishers to complete the series as soon as possible. The publishers have been encouraged by the great demand to give consideration to a new printing of the volumes already issued. As has been noted before, the price of $20 is based on a subscription to all ten volumes. The price of a single volume is $25.

Vol. 6 covers subjects alphabetically from Explosives to Furfural. Other subjects of interest are fatty oils and acids, fermentation, fibers, films, filtration, fluid mechanics, foams, foods, and fuels.

Forest Products Research Society Proceedings. Vol. 4. Forest Products Research Society, Box 2010, University Station, Madison 5, Wis., 1950. Cloth, $7^1/_2 \times 10^1/_2$, 506 pages. Illustrated. $8.00.

A compilation of the papers presented at the fourth annual meeting of the Society at Portland, Ore., in June, 1950. Its contents include subjects such as shipping containers, pulpwood supply, wallboard, softwood plywood, wood preservatives and furniture manufacture.

Practical Microscopy. 2nd Ed. By L. C. Martin and B. K. Johnson, Imperial College of Science and Technology, England. Chemical Publishing Co., Brooklyn, N. Y., 1951. Cloth, $5 \times 7^1/_2$, 124 pages. Illustrated, $2.50.

A practical treatise dealing with optics and microscopy covering such subjects as magnification, the microscope, methods of illumination, dark-ground illumination, photomicrography, preparation of specimens, polarized light, ultraviolet microscopy, and the electron microscope. In a sense the book can be considered as a manual for instruction in elementary microscopy applications.

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P125-51. Chief Engineer for nationally known company located on eastern seaboard. Experience required in converting operations, folding cartons, development work, laminating, plant layout, production flow. Must have graduate degree in either chemical or mechanical engineering. Age 35 to 45.

P126-51. Graduate Chemical or Mechanical engineer familiar with converting operations in folding cartons and/or boardmaking. Age 28 to 33. For company located in the East.

P127-51. Chemist or Chemical Engineer. Research in stream improvement and utilization of sludge from deinking mills.

P128-51. Technical Service Field Engineer. Age 26 to 35. Experienced in film packaging or with packaging machinery. Graduate chemist or chemical engineer.

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P130-51. Physical Testing Specialist to supervise physical testing of paper products in Philadelphia. Federal Civil Service requirements: (1) Approximately one and one-half years' experience in the paper industry including laboratory testing of paper products, plus bachelor's degree in a field of physical science; or (2) five and one-half years' experience without degree. Provides 26 days annual and 15 days sick leave per year. Application blanks available.

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E128-51. Analytical Chemist. Graduate of Columbia and West Virginia Universities. Ph.D. (Chemicelluloses). Eight years' teaching experience. Present position biochemist. Desires either educational or industrial technical position.

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Calendar of TAPPI Meetings

NATIONAL

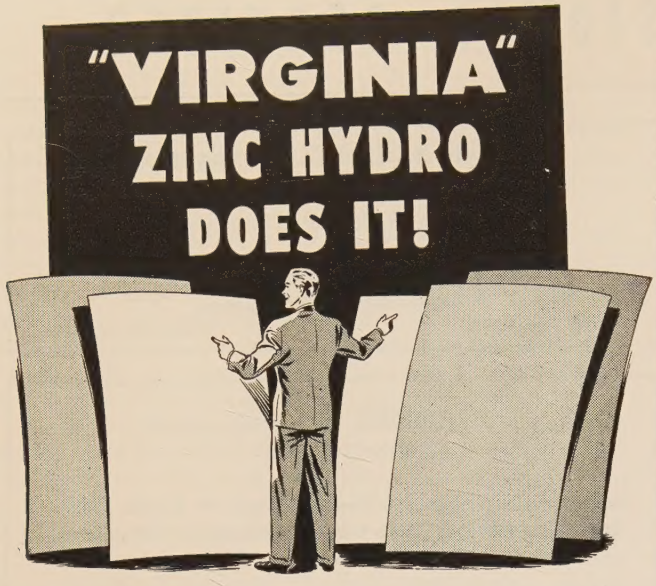
Alkaline Pulping Conference, John Marshall Hotel, Richmond, Va. September 26–28, 1951
- General Chairman—Henry Vranian, Chesapeake Corp., West Point, Va.
- Program Chairman—R. R. Fuller, Gulf States Paper Co., Tuscaloosa, Ala.

Sixth Engineering Conference of the Pulp and Paper Industry, General Oglethorpe Hotel, Wilmington Island, Savannah, Ga., October 15–18, 1951
- General Chairman—George H. Pringle, Mead Corp., Chillicothe, Ohio
- Local Arrangements Chairman—James R. Lientz, Union Bag & Paper Co., Savannah, Ga.
- Steam and Power—C. J. Sibler, Chairman.
- Materials Handling—A. P. Schnyder, Chairman.
- Drying and Ventilating—M. L. Barker, Chairman.
- Engineering Research—J. D. Lyall, Chairman.
- Mill Design—R. A. Packard, Chairman.
- Mill Maintenance—H. F. Parker, Chairman.
- Electrical Engineering—Ray Foster, Chairman.
- Hydraulics—K. J. Mackenzie, Chairman.
- Data Sheets—Henry Perry, Chairman.

LOCAL SECTIONS

Maine-New Hampshire Section:
June 22–23, 1951, Eastern Slope Inn, N. Conway, N. H.

Empire State Section:
June 28–30, 1951, Whiteface Inn, Lake Placid, N. Y.



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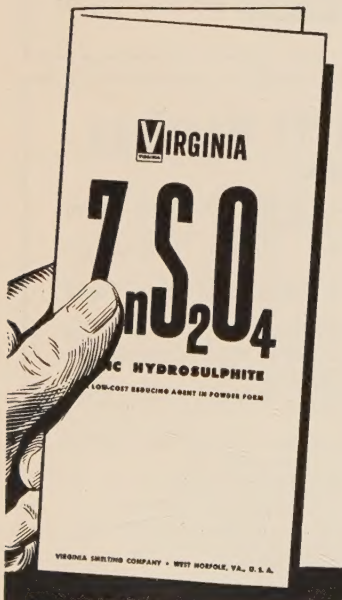

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a swing to PIGMENTED light weight papers

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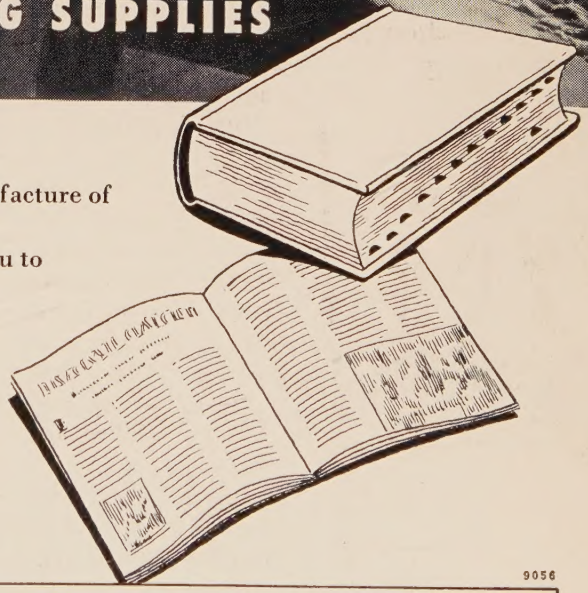

Pigmentation with titanium dioxide makes possible the manufacture of light weight papers with no increase in show-through, no loss of brightness or opacity. This type of processing enables you to increase the usefulness of your paper-making raw materials—a worthwhile consideration in times of tight supply.

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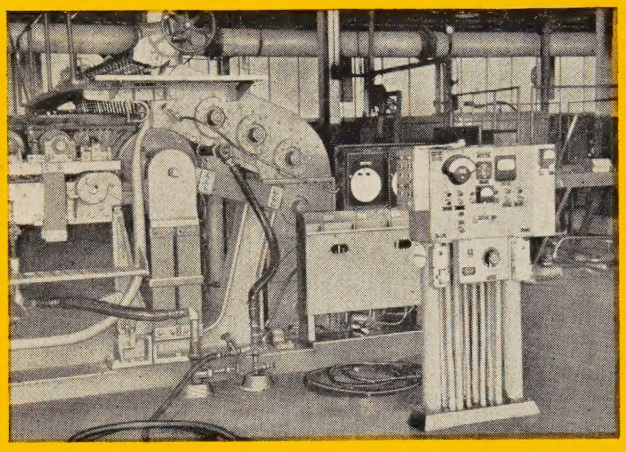
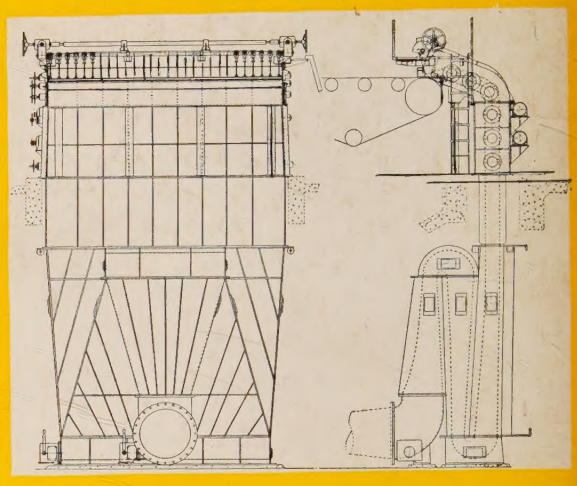
OUTSTANDING SLICE ARRANGEMENTS

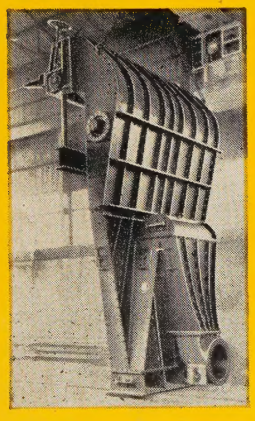


Closed Pressure Slice on machine designed for speed of 2100 feet per minute.



Assembly drawing of Flow Spreader and Closed Pressure Slice.

Shop assembly of Flow Spreader and High Slice.



The new Puseyjones Closed Pressure Slice combined with the Flow Spreader, now proved in mill operation, provides the ideal approach flow to the Fourdrinier wire on today's high-speed machines.

Three of these Slices are now in operation . . . and three are under construction.

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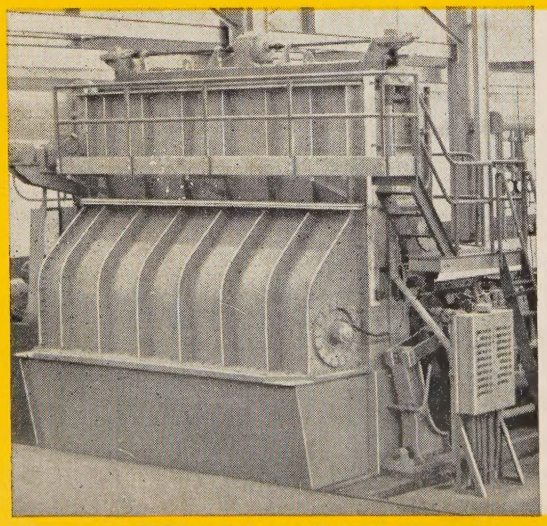
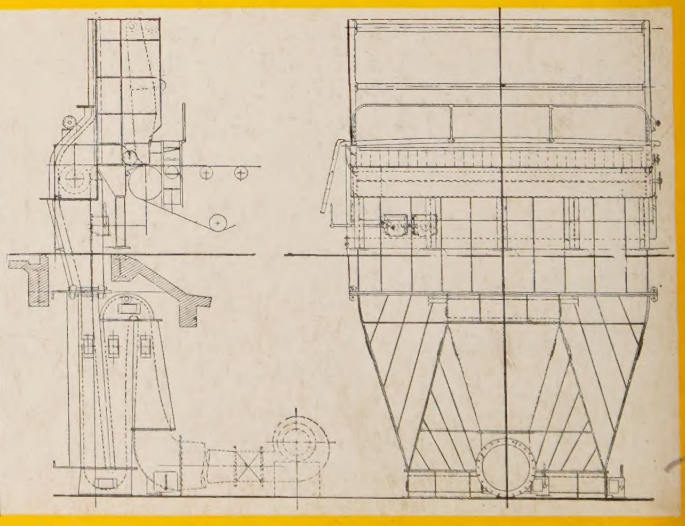


Mill installation of High Slice.



Assembly drawing of Flow Spreader and High Slice.